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9. For the standardised common and scientific names of the birds of the Indian subcontinent refer to *Buceros* Vol. 6, No. 1 (2001).

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Cover Photograph: Karvi *Carvia callosa*
by Ashok Kothari

Editorial

Karvi or the common conehead was first described and named *Strobilanthes callosus*, by the German botanist Nees in Nathaniel Wallich's RARE PLANTS OF ASIA published in 1832. Karvi belongs to the group of plants called pliestosials, which flower once in several years. Bamboos are another example. John Graham, the Presidency Postmaster of Bombay, quoting local tribals in his catalogue of Bombay plants recorded that karvi flowers every ten years. Duthie (*JBNHS* 5: 417-8, 1890) quoting natives of the Tapti Valley says that its flowering cycle was three years, but his observations on plants of Western Ghats placed it between 8 and 9 years. Its flowering cycle, once in seven years at Khandala, during April-May, was first noted in 1928 by Charles McCann, then Asst. Curator of the BNHS. Thereafter, this record was confirmed from the same area by Rev. Fr. H. Santapau in 1942 and again in 1949. Bremekamp raised the species to monotypic generic status, based on the absence of bracteoles in the flowers, naming it *Carvia callosa* (Nees) Bremekamp, using its local common name karvi for the generic epithet. Lisboa in the *Journal of the Royal Asiatic Society Bombay* (1883), and the European traveler Clement Markham in TRAVELS IN PERU AND INDIA (1984) have praised this beautiful flowering plant of the Western Ghats. Constable commented on its pleasant, sweet, resinous, aromatic odour scenting the air, and the scent lingering on the hands after touching the bracts, even after washing them thrice over. He published a beautiful colour plate of the flowers in Curtis' Botanical Magazine (plate no.7538) in 1897. Since then, it has attracted and inspired many artists and photographers at various places like Amboli, Borivli National Park, Khandala, Mahabaleshwar and Matheran in Maharashtra.

Rev. Fr. Santapau described the plant as the King of the Khandala slopes. The flower is generally white on the tube and purple on the petals. However, like many other Acanthaceae, the petals sometimes vary in colour from pink or blue to pure white, depending upon the colour-gene carrier insect pollinators.

Karvi is rich in honey, which is valued for its medicinal properties, and the gregarious flowering provides exceptionally high yield. Observations during the 1960 flowering season at Mahabaleshwar showed that the concentration of the nectar in flowers, which is 20-25% around 8 a.m., increases to 37% around noon, and remains static until 3 p.m. before declining. The leaves are toxic and non-palatable for cattle and humans, causing vomiting and inflammation of the mucous membrane of the stomach. However, the plant is esteemed for its insect repellent properties and in Junagadh, it is reported to have been used to protect woollens from insect pests. The bark is used in the preparation of an external application in parotitis, and the flowers are considered vulnerary. Its straight stems are used by the local tribals for the construction of house walls, plastered together with mud and cow-dung.

M.R. ALMEIDA

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Editors

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THE HONEY BEES OF INDIA, HYMENOPTERA: APIDAE[1]

MICHAEL S. ENGEL[2]

(*With one text-figure*)

Key words: *Apis*, Apoidea, honey bees, key, systematics

A summary is given for the honey bee species (*Apis* Linnaeus) indigenous to India. Four indigenous species are recognized from the region; *Apis cerana*, *A. dorsata*, *A. florea* and *A. andreniformis*. All are commonly found in India except for *A. andreniformis*, which is only known from a few specimens collected in the northeastern boundaries of the country. A dichotomous key is presented to aid the identification of these species and notes given on how to separate them from the introduced western honey bee, *A. mellifera*.

INTRODUCTION

The honey bees (genus *Apis* Linnaeus) are by far the most famous of all insects owing to their production of honey, pollination of crop plants, and advanced eusocial behaviour, which has attracted much attention from biologists. Unfortunately, the systematics of this small and highly visible group is not clearly understood. This is partly owing to the high levels of variation within species and to the recent divergence times between taxa. Surprisingly, few modern monographs have been produced to clarify the taxonomic confusion within this important group of bees. The last monograph for the genus was undertaken by Maa (1953); however, his extreme classification recognized 24 species and subspecies in three genera. It is sometimes difficult when utilizing his keys and classification to reconcile names with the seven species generally recognized today.

Most authors today agree upon at least six species: *Apis mellifera* Linnaeus (1758), *A. cerana* Fabricius (1793), *A. dorsata* Fabricius (1793), *A. florea* Fabricius (1787), *A. andreniformis* Smith (1858), and *A. koschevnikovi* Enderlein (1906: not Buttel-Reepen [1906], see Engel [1999]). The Sulawesi bee, *A. nigrocincta* Smith (1861) is also deserving of specific rank, as has been demonstrated by Hadisoesilo *et al.* (1995) and Hadisoesilo and Otis (1996, 1998). Although this taxon was in the past not considered specifically distinct (Engel 1998) it has since been added to the list of valid honey bee species (Engel 1999). Currently, the giant Himalayan honey bee, *A. laboriosa* Smith (in Moore *et al.* 1871), is considered a subspecies of *A. dorsata* (e.g., Engel 1999), but continued work on this taxon may later reinstate it as a separate species. A similar argument can be made for the Bomean honey bees known as *A. nuluensis* Tingek *et al.* (1996) but they are for now best classified as a subspecies of *A. cerana*.

Most recently, Engel (1999) has listed the species in the genus, both recent and fossil, with

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detailed taxonomic histories for all species and subspecies. He has provided revised diagnoses for the genus and its subgenera, and detailed a phylogenetic hypothesis of their relationships. Table 1 outlines the classification of honey bees as it is presently conceived.

Herein I provide a key to the indigenous species presently known from India. The dichotomous key is primarily designed for the worker bees, since this is the caste most often encountered in the field. However, characters for drones and queens are also included, and these castes can be identified with the key. For detailed taxonomic histories of each species refer to Engel (1999).

Key to the Indian tribes of Corbiculate Apinae

1. Jugal lobe of hind wing present (Fig. 1b); metatibial spurs absent; arolia present; outer grooves of mandible absent 2

— Jugal lobe of hind wing absent; metatibial spurs present; arolia absent or reduced; outer grooves of mandible present (Bumble bees; genus *Bombus* Latreille) .... Bombini

2. Forewing with reduced distal wing venation, marginal cell frequently open at apex; claws simple; penicillum present in worker; auricle absent; sting reduced (Stingless bees; numerous genera) .... Meliponini

— Forewing with complete distal wing venation, marginal cell long and completely bordered by veins (Fig. 1a); claws cleft; penicillum absent in worker; auricle present; sting well developed (Honey bees; genus *Apis* Linnaeus) ...... Apini

Genus *Apis* Linnaeus

The genus can be distinguished from other corbiculate members of the Apinae by the following combination of characters (see also diagnosis presented by Engel 1999): compound eyes with long, fine hairs; metatibia lacking penicillum; metatibial spurs absent; claws cleft; arolia present; wing venation strong and complete; marginal cell long, bluntly rounded at apex, not tapering along its length; jugal lobe present; compound eyes of drones meet at top of head. Three extant subgenera are recognized (Engel 1999); the giant honey bees, subgenus

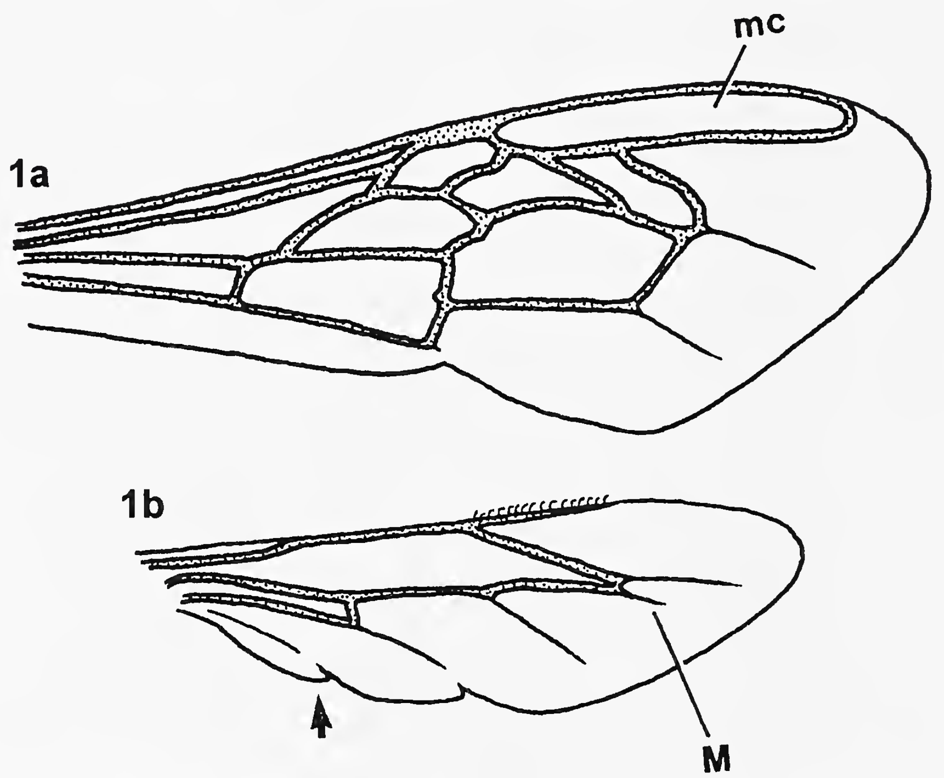

Fig. 1: Diagrammatic wing venation of *Apis* (*Apis*) *cerana* Fabricius
a. Forewing showing the elongate marginal cell (mc) typical of *Apis*, b. Hind wing showing distal abscissa of the Median (M) vein; arrow indicates jugal lobe.

Megapis; the dwarf honey bees, subgenus *Micrapis*; and the typical honey bees, subgenus *Apis* s. str. All three subgenera natively occur in India. Both species of the subgenus *Micrapis* are recorded from India while only a single species of *Apis* s str. is native to the country. The subgenus *Megapis* is monotypic and represented by *A. dorsata*. The indigenous species in India all nest in the open, except for *A. cerana* which nests in cavities.

The western honeybee, *A. mellifera*, has been introduced into India for agricultural purposes. This introduced species is not included in the key below. It can be separated from the native species before attempting to use the key, by the following combination of characters: distal abscissa of vein M in hind wing absent; size moderate (7-10 mm); wings hyaline; drones without metabasitarsal process.

Key to the native *Apis* of India
(Workers, queens, and drones)

1. Distal abscissa of vein M in hind wing present; worker size variable, moderate to large, forewing length 7-15 mm (subgenera *Apis* and *Megapis*) 2

Table 1
HIERARCHICAL CLASSIFICATION OF HONEY BEES (ENGEL, 1999)

GENUS APIS LINNAEUS
Subgenus *Apis* Linnaeus
- *A. cerana* Fabricius*
  - *A. c. cerana* Fabricius*
  - *A. c. heimifeng* Engel
  - *A. c. indica* Fabricius*
  - *A. c. japonica* Radoszkowski
  - *A. c. javana* Enderlein
  - *A. c. johni* Skorikov
  - *A. c. nuluensis* Tingek *et al.*
  - *A. c. skorikovi* Engel
- *A. koschevnikovi* Enderlein
- *A. mellifera* Linnaeus
  - *A. m. adami* Ruttner
  - *A. m. adansonii* Latreille
  - *A. m. anatoliaca* Maa
  - *A. m. artemisia* Engel
  - *A. m. capensis* Eschscholtz
  - *A. m. carnica* Pollmann
  - *A. m. caucasia* Pollmann
  - *A. m. cecropia* Kiesenwetter
  - *A. m. cypria* Pollmann
  - *A. m. iberiensis* Engel
  - *A. m. intermissa* Maa
  - *A. m. jemenitica* Ruttner
  - *A. m. lamarckii* Cockerell
  - *A. m. ligustica* Spinola
  - *A. m. litorea* Smith
  - *A. m. macedonica* Ruttner
  - *A. m. meda* Skorikov

Table 1 (contd.)
HIERARCHICAL CLASSIFICATION OF HONEY BEES (ENGEL, 1999)

  - *A. m. mellifera* Linnaeus
  - *A. m. monticola* Smith
  - *A. m. remipes* Gerstäcker
  - *A. m. ruttneri* Sheppard *et al.*
  - *A. m. sahariensis* Baldensperger
  - *A. m. scutellata* Lepeletier de Saint Fargeau
  - *A. m. siciliana* Grassi
  - *A. m. sossimai* Engel
  - *A. m. syriaca* Skorikov
  - *A. m. taurica* Alpatov
  - *A. m. unicolor* Latreille
- *A. nigrocincta* Smith

subgenus *Cascapis* Engel †
- *A. armbrusteri* Zeuner †

subgenus *Megapis* Ashmead
- *A. dorsata* Fabricius*
  - *A. d. binghami* Cockerell
  - *A. d. breviligula* (Maa)
  - *A. d. dorsata* Fabricius*
  - *A. d. laboriosa* Smith

subgenus *Micrapis* Ashmead
- *A. andreniformis* Smith*
- *A. florea* Fabricius*

subgenus *Priorapis* Engel †
- *A. vetusta* Engel †

subgenus *Synapis* Cockerell †
- *A. henshawi* Cockerell †
- *A. longtibia* Zhang †
- *A. miocenica* Hong †
- *A. petrefacta* (Ríha) †

(†) indicates fossil taxa,
(*) indicates taxa natively occurring in India.
Several of the subspecies presently recognised in *A. mellifera* should probably be synonymized (e.g. *A. mellifera taurica*).

— Distal abscissa of vein M in hind wing absent; worker size small, forewing length 6-7 mm. (subgenus *Micrapis*) 3

2. Forewing hyaline; scutellum yellow-brown, rarely black; drone with tarsi unmodified; worker size moderate, forewing length 7-9 mm. (subgenus *Apis* s. str.) .... *A. cerana*

— Forewing fuscous; scutellum black; drone with dense frond-like setae on meso- and metatarsi; worker size large, forewing length 12-15 mm (subgenus *Megapis*). .... *A. dorsata*

3. Metatibia and dorsolateral margin of metabasitarsus with black setae; metasomal terga 1-2 black, infrequently with reddish-brown hints apically on tergum 1 or basally on tergum 2; drone metabasitarsal process short, less than one-half metabasitarsus length .... *A. andreniformis*

— Metatibia and dorsolateral margin of metabasitarsus with white setae; metasomal terga 1-2 reddish-brown; drone metabasitarsal process long, more than two-thirds metabasitarsus length .... *A. florea*

1. ***Apis (Apis) cerana*** Fabricius, Eastern honey bee: This is the species most often kept in apiaries and used for agricultural purposes as has been done for nearly 5 millenia in India (Joshi *et al.* 1980), although to a lesser degree since the introduction of *A. mellifera*. Feral colonies typically nest in tree hollows, unlike the other three Indian species, which nest openly.

Apis cerana is genetically diverse in India with a distinctive western and eastern mitochondrial DNA type (Smith and Hagen 1996). These genetic haplotypes correspond to the "plains bee" and "hills bee" morphs of Ruttner (1988) respectively. The plains bee taxonomically corresponds to the subspecies *A. cerana indica* Fabricius (1798) while the hills bee appears to be *A. cerana cerana*. Eight subspecies of *A. cerana* are recognized, although only two are presently understood to occur in India (Engel 1999; Table 1).

2. ***Apis (Megapis) dorsata*** Fabricius, Giant honey bee: This species is commonly referred to as the giant honey bee owing to its large body size. Workers of *A. dorsata* can be quite vicious when the colony is disturbed and their sting is probably the most painful of any honey bee species. Much of the wax and honey harvested in India comes from this species (Thakar and Tonapi 1961, Singh 1980). It builds nests most often high in trees usually affixed to the underside of strong limbs.

Four subspecies are presently recognized in *A. dorsata* (Table 1), but only the nominate subspecies is found in India.

3. ***Apis (Micrapis) florea*** Fabricius, Red dwarf honey bee: These tiny bees are relatively docile and can be worked with little difficulty; however, some nest disturbances can cause the colony to abscond and rarely are *A. florea* colonies managed by beekeepers. As noted by Otis (1991, 1996), in northeastern India where *A. florea* and *A. andreniformis* overlap, *A. andreniformis* occurs at higher elevations while *A. florea* occurs in the lowlands.

4. ***Apis (Micrapis) andreniformis*** Smith, Black dwarf honey bee: Unlike its sister species, *A. florea*, which occurs throughout India, *A. andreniformis* is presently restricted to the northeastern regions of the country and is exceedingly uncommon. Otis (1996) gives the distribution for *A. andreniformis* over the entirety of its range and records the few localities from Meghalaya, Sikkim and West Bengal, where it has been captured. The species is probably more common in Bhutan and Nepal, but no collection records have yet been made. *Apis andreniformis* was only recently reinstated as a valid species of the genus by Wu and Kuang (1986, 1987) and further confirmed by Wongsiri *et al.* (1990).

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STRUCTURE AND COMPOSITION OF TWO BIRD COMMUNITIES IN THE SOUTHERN WESTERN GHATS[1]

E.A. Jayson[2] and D.N. Mathew[3]

(*With 5 text-figures*)

Key words: Bird community, tropical forest, Western Ghats, Kerala, India

The structure and composition of bird communities was studied in the Tropical Evergreen and Moist Deciduous forests of Silent Valley and Mukkali in the Western Ghats of south India from 1988 to 1993. Variable width line transects were employed to assess the bird community each month. To correlate the structure and composition of bird community to the vegetation type, parameters like girth class distribution of trees, maturity index of vegetation and vegetation profile diagrams were prepared. A total of 9,921 birds were recorded during the period of study, and altogether 137 taxa of birds were identified from the two vegetation types. Species richness of birds was similar in both the habitats. The yellow-browed bulbul (*Hypsipetes indicus*) was the most common and dominant species at Silent Valley (Tropical Evergreen), whereas at Mukkali (Tropical Moist Deciduous) black drongo (*Dicrurus adsimilis*) was the most common and jungle babbler (*Turdoides striatus*) was the dominant species. No significant difference in bird species richness between years was found in the Tropical Evergreen forests, whereas significant difference in species richness was obtained between different years in the Tropical Moist Deciduous Forest. The study showed that a high diversity index of vegetation (H') is an indication of increased density of birds in tropical forests.

Introduction

The structure and composition of bird communities are known to vary in different vegetation types (Wiens 1989). The pioneering studies of MacArthur and MacArthur (1961) established the relationship between bird diversity and vegetation structure. MacArthur *et al.* (1962), and MacArthur *et al.* (1966), supported the above hypothesis, but some studies showed negative relationship also (Wiens 1983). Studies on forest bird communities mainly examined parameters like the structure of forest bird communities (Nilson 1983), distributions (Howe *et al.* 1981) and community organization (Landers and MacMahon 1980). Yorke (1984) and Terborgh *et al.* (1990) described the community structure of tropical forest birds. Many workers have demonstrated the relationship between bird communities and forest structure (Karr 1971, Karr and Roth 1971, Beedy 1981 and Rice *et al.* 1984). The roles of vegetation structure, competitors and productivity were described by Cody (1981) and the relation between total crown volume and bird diversity by Verner and Larson (1989). Similarly, patchiness of shrub distribution to diversity (Roth 1976), species richness to plant taxa (Terborgh 1985), tree species richness (James and Warmer 1982) and birds in plantations and indigenous forest were described by Carlson (1986).

Even though many aspects of birds were studied in the Western Ghats of south India, (Vijayan and Balakrishnan 1977, Vijayan 1978, Zacharias and Gaston 1993, Srivastava *et al.* 1993, Nair *et al.* 1997) community studies of birds are few in number. Earlier workers (Anon. 1990) also carried out many faunal studies in the Evergreen Forests of Silent Valley. While studying the bird communities in the forests of northern Kerala, Ramakrishnan (1983) examined certain aspects of birds of Silent Valley. The relationship between birds and vegetation in New Delhi was revealed by Gaston (1979).

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Gandhi (1986) compared the bird community structure of scrub jungle and monoculture plantations. Diversity and community structure of birds were also studied by Daniels (1989), Daniels *et al.* (1990), Katti (1989) and Sundaramoorthy (1991).

The objective of the study was to evaluate and compare the structure and species composition of bird communities at two ecologically different habitats. Three characters of vegetation were analysed to compare and find out the relationships between the vegetation and bird community. The study forms part of a major investigation (Jayson 1994), which determined many ecological aspects of two bird communities. Seasonal changes in these bird communities were reported earlier (Jayson and Mathew 2000). Diversity and species abundance and distribution were also published (Jayson and Mathew 2000a).

Study Area

The study area is located in Palakkad district, Kerala State, 45 km north of Mannarghat, the nearest town, in the Western Ghats of south India between 11° 3'-11° 13' N and 76° 25'-76° 35' E. After evaluating the entire area, two study sites were selected: a Tropical Evergreen Forest, Silent Valley, and a Moist Deciduous Forest at Mukkali. The detailed description of the study areas with a map has been given earlier (Jayson and Mathew 2000). The first site is partially degraded and most of the disturbance happened in the late seventies and early eighties, in the course of felling trees and pre-construction work of an abandoned dam. The elevation of the tract varies from 500 m to 1,500 m above msl and the topography is undulating. These two study sites are separated by about 20 km, but the vegetation types differ. Anthropomorphic pressures were severe at Mukkali due to the proximity to human habitations. There was also a difference of 400 m in elevation between the two sites. There are two distinct seasons in the study area, monsoon season from end of May up to mid-November, and the dry summer season from December to April. There is no clearly marked winter. Fast southwesterly winds blow from the western side during the monsoon. Ombrothermic diagrams of Silent Valley and Mukkali are given in Figs 1 and 2.

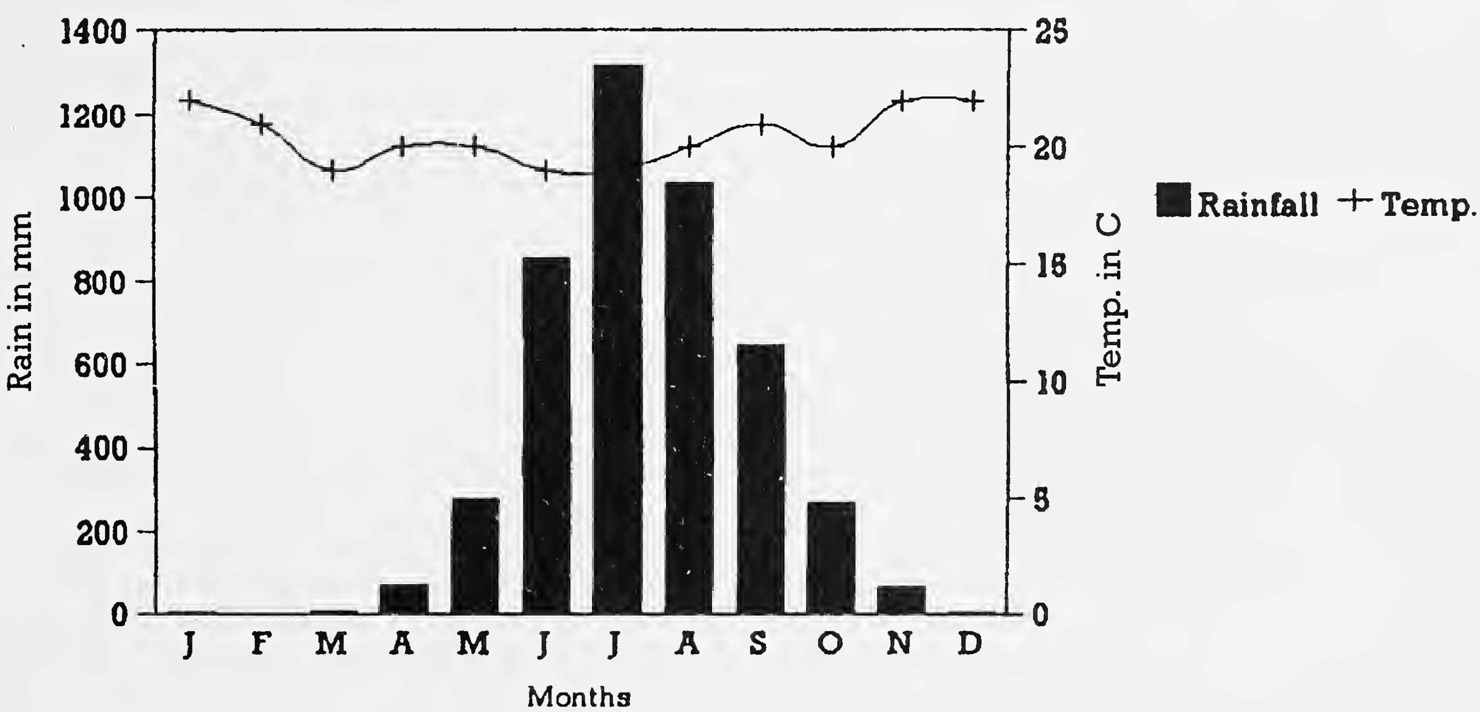

Fig. 1: Ombrothermic diagram of Silent Valley (1988-1993)

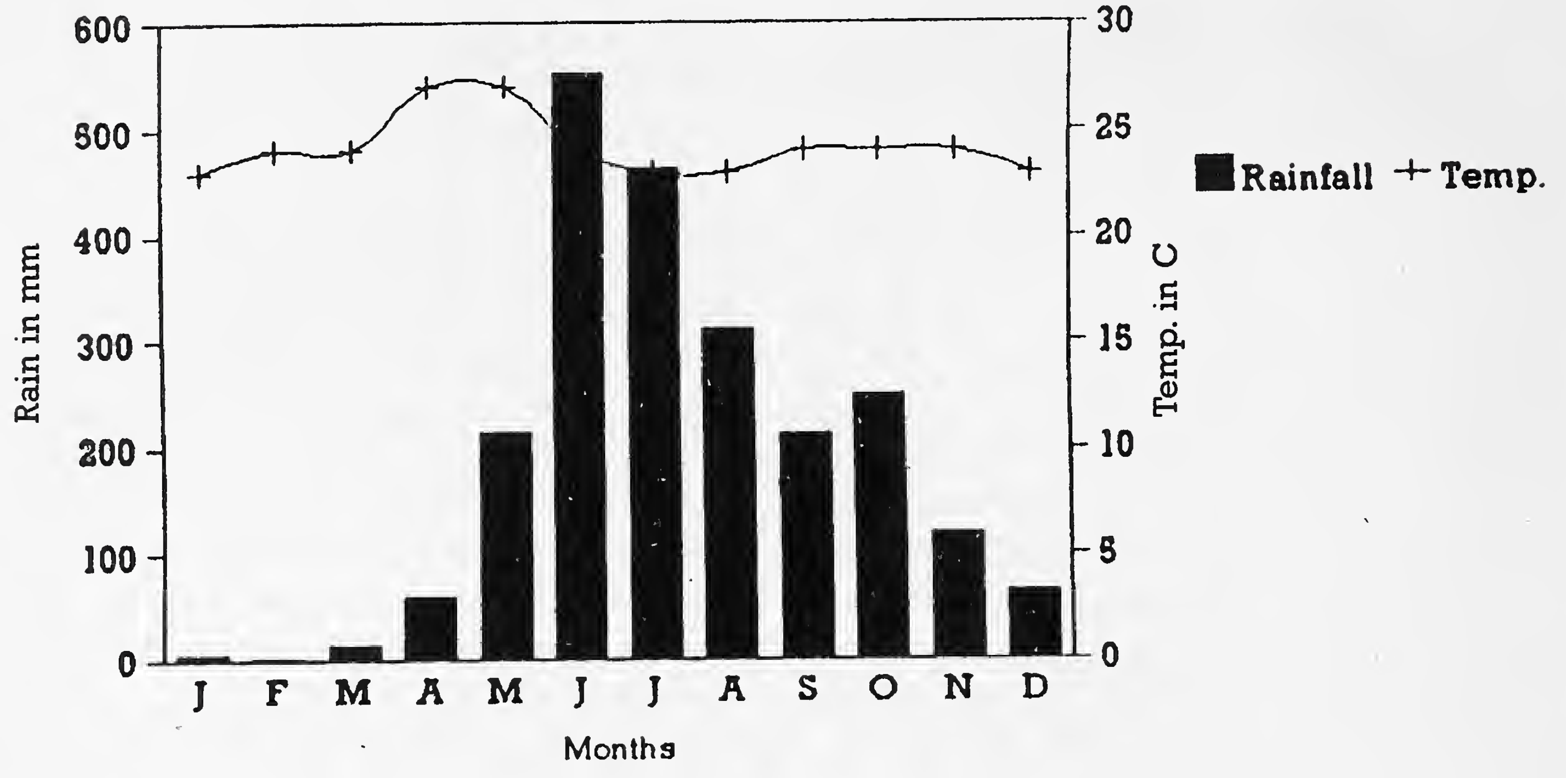

Fig. 2: Ombrothermic diagram of Mukkali (1988-1993)

METHODS

Vegetation: The vegetation structure, vegetation structure profile and the girth class distribution of trees in the study area were analysed. In addition to this, percentage composition of trees at the two areas was also measured.

Vegetation structure profile: A schematic diagram, which resembles the physiognomy of the stands of forest, is shown in the form of a profile diagram. It depicts a representative forest stand pictorially, size to scale. A 5 m x 50 m strip of forest stand was demarcated, and the position of each tree in it was marked on graph paper. Girth at breast height (GBH) and total height were recorded using a range finder. Crown shapes of individual trees were drawn on graph paper in the field. Using these pictorial and quantitative data, a profile diagram with measurements to scale (Richards 1952) was constructed.

Girth class distribution: Girth of trees at breast height (GBH) with more than 10 cm was measured randomly on both sides of the transect within a width of 30 m from the central line at Silent Valley and Mukkali. Altogether, 795 trees were measured at Silent Valley and 552 trees were enumerated at Mukkali. From this data, girth class distribution was plotted.

Percentage composition of trees: One hundred plots of 5 m radius each in Silent Valley and 200 such plots in Mukkali were enumerated. Plots were enumerated on both sides of the transect line, the minimum distance between plots was 25 m. Among the 200 plots at Mukkali, 100 were in natural forest and the rest were in the coffee estate. All the trees above 10 cm in GBH were identified and recorded. The diversity and percentage composition of trees were worked out using the following formulae (Phillips 1959).

$$\text{Density (D)} = \frac{\text{Total number of individuals}}{\text{Total number of quadrats studied}}$$

$$\text{Abundance (Ab)} = \frac{\text{Total number of individuals}}{\text{Number of quadrats of occurrence}}$$

$$\%\ \text{Frequency}\ (\%\ \text{F}) = \frac{\text{Number of quadrats of occurrence}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative density (RD)} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} \times 100$$

$$\text{Relative frequency (RF)} = \frac{\text{Number of occurrence of the species in the quadrat}}{\text{Number of occurrence of all species}} \times 100$$

The following formula is used to estimate maturity index value from the two study areas (Pichi-Sermolli 1948).

$$\text{Maturity index (MI)} = \frac{\text{Total \% frequency of a locality}}{\text{Total number of species present}}$$

Diversity was calculated using Shannon-Wener Index ($H' = -\sum (pi \ln pi)$ with the program SPDIVERS.BAS developed by Ludwig and Reynolds (1988).

Birds: After considering all the available methods, the Variable Width Line Transect Method described by Burnham *et al.* (1980) was adopted, in which the observer walks through a fixed path, counting the birds seen or heard on both sides of the path. Whenever a bird was spotted, it was identified up to species and details like the number of birds, and habitat were noted. Birds were identified using a binocular (10 x 30) and with the help of field guides and reference books (Ali 1969, Ali and Ripley 1983). Additionally, whenever a bird was sighted in the study period, it was identified and recorded.

Two line transects, each 4 km in length, were selected, one at Silent Valley and another at Mukkali. The transects covered representative habitats of the area, the first transect covered Evergreen Forest, burnt areas, and the second transect covered Moist Deciduous Forest, rocky patches, and burnt Moist Deciduous Forest. Observations were started 30 minutes after sunrise in all the months, and no census was done on days with very heavy rain and fog. Two observations were carried out in each area in a month. Altogether 150 samples of line transects were collected from the study area between May 1988 and April 1993. Among these, 80 line transects were from Silent Valley and 70 were from Mukkali spread over 45 months. There was a gap of 8 months from May 1991 to December 1991 in the collection of data.

To find out the common bird species of each area the Commonness Index of the two areas was computed. Commonness Index is the average frequency of sighting of a species in one sampling at a site. The relative dominance of each bird species in the two areas was determined by calculating the Dominance Index. The following formula was used for calculating Relative Dominance.

Relative Dominance = ni x 100/N

Where ni = number of individuals of the species.

N = The total number of individuals of all the species seen during the study period.

RESULTS

Vegetation

Vegetation structure profile: Vegetation profile diagram of the Evergreen Forests showed trees in three canopy layers (Fig. 3). Trees having a height of more than 30 m were quite common; the trees were densely packed. One peculiarity

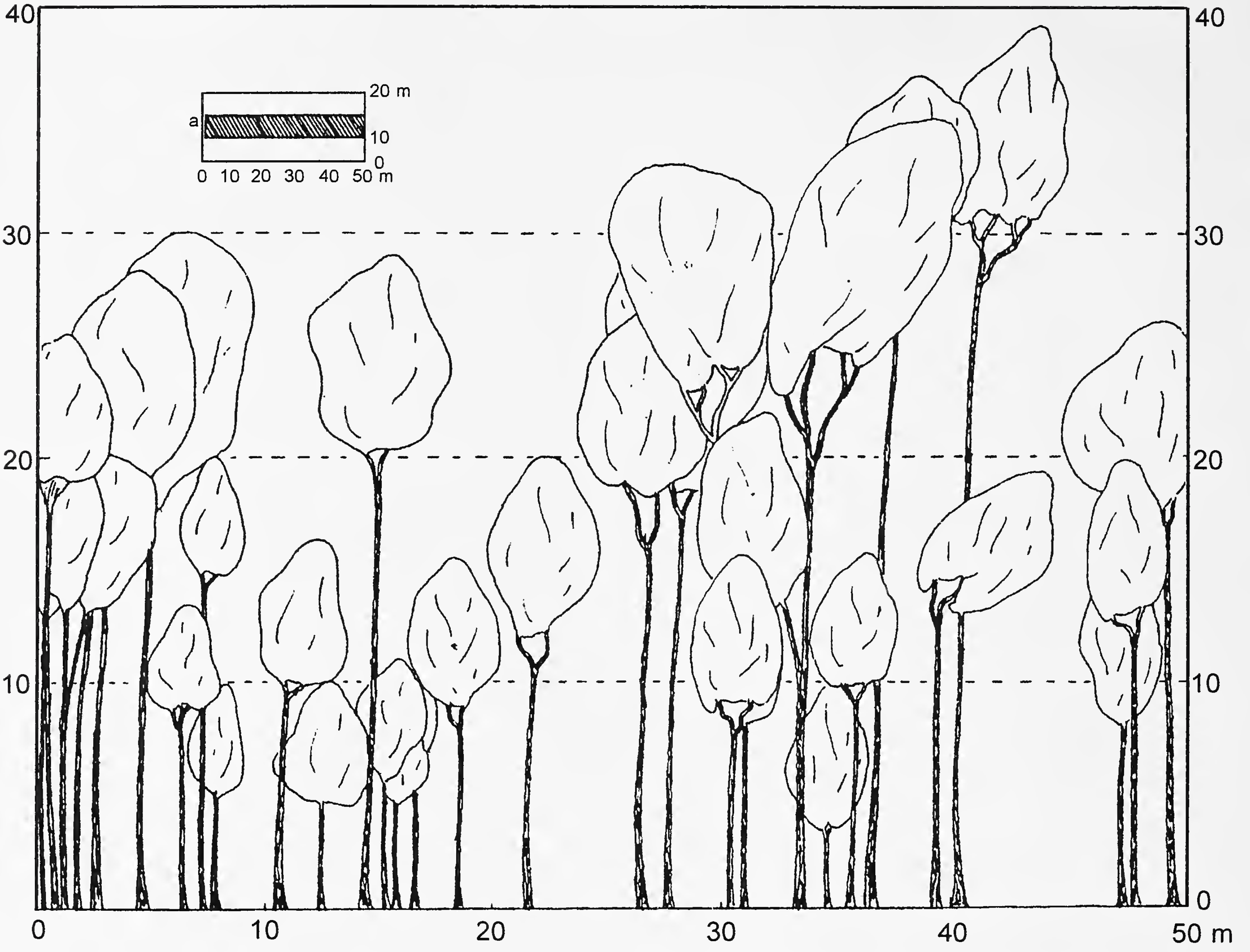

Fig. 3: Vegetation profile (5 m x 50 m) of Silent Valley showing different canopy levels

at Silent Valley was the presence of shola forests. The vegetation profile diagram of Mukkali showed only two distinct canopy levels (Fig. 4). Trees having a height of more than 30 m were very rare; the individual trees were very loosely packed.

Girth class distribution: Girth class distribution of trees (more than 10 cm GBH) recorded from Silent Valley and Mukkali is shown in Fig. 5. Being a wet Evergreen Forest, trees having more than 270 cm GBH were common at Silent Valley; but at Mukkali trees of large GBH were absent. Newly introduced trees in Mukkali were less than in Silent Valley (10-30 cm class). The prospect of new introductions in Mukkali was also poor, mainly due to the illegal removal of poles for household purposes and firewood by locals. Most of the natural tree growth in the estate was maintained to provide shade to the coffee and pepper. The vegetation of this area was degraded and burnt clumps of bamboo were seen intermittently.

The following trees and shrubs were recorded from Mukkali: *Terminalia bellerica*, Eucalyptus, *Dalbergia lanceolaria*, *D. latifolia*, *Leucaena leucocephala*, *Erythrina suberosa*, *Grevillea robusta*, *Calotropis gigantea*, *Bambusa bambos*, *Ficus carica*, *Cassia fistula*, *Carica papaya*, *Grewia tiliaefolia*, *Bauhinia racemosa*, *Acacia concinna*, *Albizzia lebbeck*, *Tamarindus*

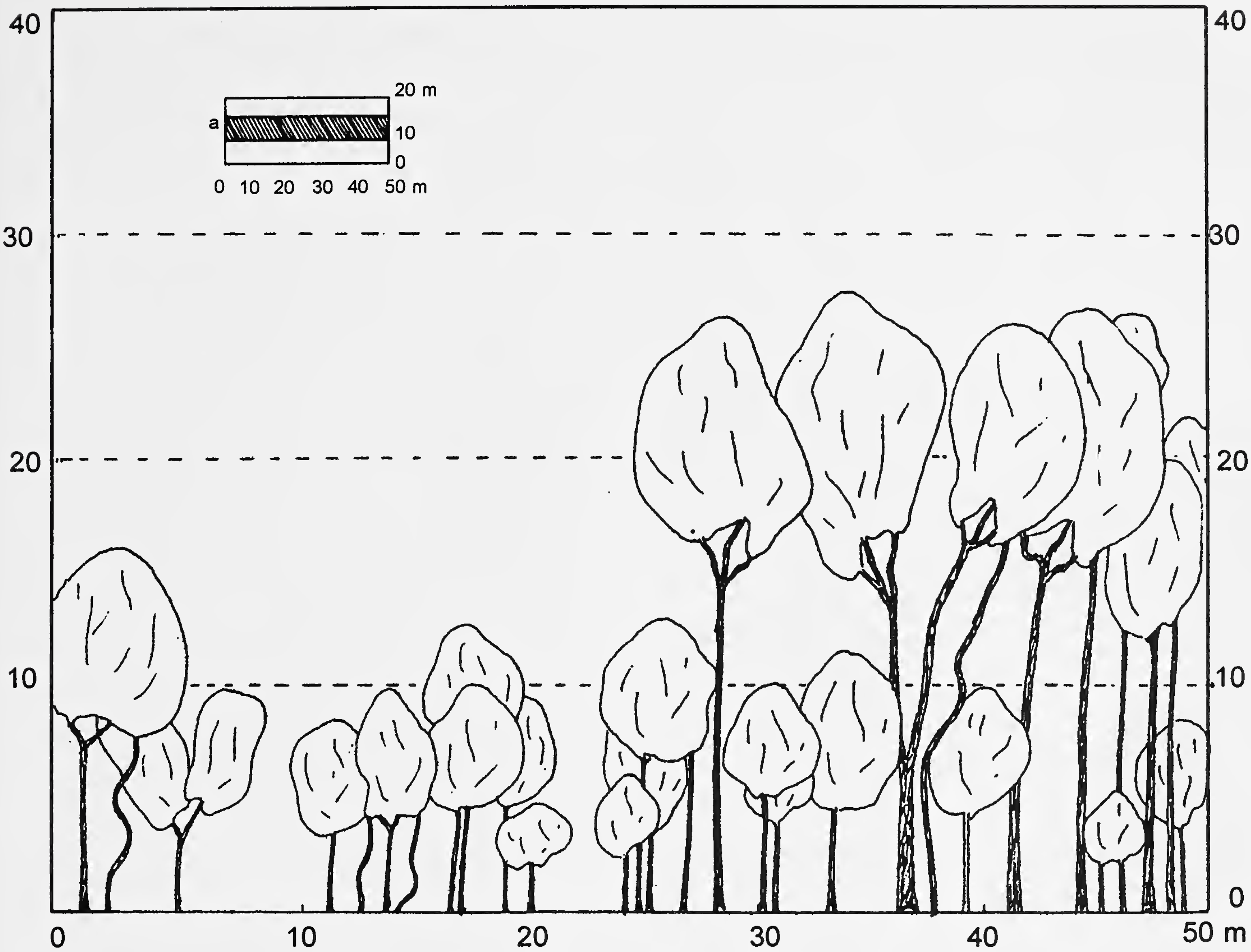

Fig. 4: Vegetation profile (5 m x 50 m) of Mukkali showing different canopy levels

indica, *Emblica officinalis*, *Pterocarpus marsupium*, *Solanum* sp., *Lantana camara*, *Antiaris toxicaria*, *Cycas* sp. and *Calophyllum inophyllum*. Other tree species included *Lagerstroemia flos-reginae*, *Litsea zeylanica*, *Cenchrus inhirini*, *Psychotria* sp., *Cipadessa baccifera*, *Xylia xylocarpa*, *Haldina cordifolia*, *Lagerstroemia microcarpa* and *Macaranga peltata*. Common shrubs recorded from the area were *Abutilon indica*, *Crotalaria* sp., *Pimpinella heyneana*, *Hibiscus* sp., *Impatiens flaccida* and *Heliotropium scabrum*. Grasses recorded were *Pennisetum*, *Thomeda* and *Cymbopogon*.

Percentage composition of trees: *Silent Valley*: Fifty-three species of trees were recorded from the plots at Silent Valley (Table 1). *Macaranga peltata* with 140 individuals had the greatest abundance (2.85), highest density (0.70) and frequency (24.50) among the vegetation recorded (Table 1). Its relative density and frequency was also higher than the other vegetation. Maturity index of the vegetation at Silent Valley was 2.85 and Shannon-Wener diversity index was 2.91.

Mukkali: Twenty-two tree species numbering about 256 individuals were recorded from the plots (Table 2). *Albizzia* had the greatest density and frequency, while *Terminalia chebula* was the most abundant among the other vegetation recorded.

Coffee Estate: *Terminalia paniculata* was the most dense and frequent, while *Erythrina suberosa* was the most abundant (Table 3). The maturity index of the natural forest was 10.00

TABLE 1
ABUNDANCE OF TREE SPECIES AT SILENT VALLEY (TROPICAL EVERGREEN FOREST)

Species	No. of individuals	D	Ab	% F	RD	RF
Macaranga peltata	140	0.70	2.85	24.50	30.43	16.0
Unidentified	2	0.01	2.00	0.50	0.43	0.32
Persea macrantha	7	0.03	1.16	3.00	1.52	1.96
Cinnamomum zeylanicum	1	0.01	1.00	0.50	0.21	0.32
Schleichera oleosa	6	0.03	1.00	3.00	1.30	1.96
Diospyros sp.	1	0.01	1.00	0.50	0.21	0.32
Unidentified	7	0.03	1.40	2.50	1.52	1.63
Palaquium ellipticum	28	0.14	1.40	10.00	6.08	6.55
Cullenia sp.	5	0.02	1.66	1.50	1.08	0.98
Vateria indica	4	0.02	1.33	1.50	0.87	0.98
Melia dubia	15	0.07	1.15	6.50	3.26	4.26
Antidesma sp.	8	0.04	1.00	4.00	1.73	2.62
Syzygium cumini	4	0.02	1.00	2.00	0.87	1.31
Unidentified	15	0.07	1.25	6.00	3.26	3.93
Macaranga indica	52	0.26	1.52	17.00	11.30	11.14
Artocarpus integrifolia	3	0.01	1.00	1.50	0.65	0.98
Unidentified	1	0.01	1.00	0.50	0.21	0.32
Unidentified	1	0.05	1.00	0.50	0.21	0.32
Myristica attenuata	12	0.06	1.50	4.00	2.60	2.62
Trema orientalis	1	0.01	1.00	0.50	0.21	0.32
Lansium sp.	16	0.08	1.45	5.50	3.47	3.60
Bischofia javanica	20	0.10	1.05	9.50	4.34	6.22
Unidentified	4	0.02	1.00	2.00	0.87	1.31
Unidentified	1	0.01	1.00	0.50	0.21	1.31
Unidentified	1	0.01	1.00	0.50	0.21	0.32
Alstonia scholaris	1	0.01	1.00	0.50	0.21	0.32
Xanthophyllum flavescens	1	0.01	1.00	0.01	0.21	0.32
Symplocos sp.	1	0.01	1.00	0.50	0.21	0.32
Mangifera indica	1	0.01	1.00	0.50	0.21	0.32
Sterculia foetida	1	0.01	1.00	0.50	0.21	0.32
Trema orientalis	2	0.01	1.00	0.50	0.43	0.65
Black berry	3	0.01	1.50	1.00	0.43	0.65
Unidentified	2	0.01	1.00	1.00	0.43	0.65
Unidentified	1	0.01	1.00	0.50	0.21	0.32
Elaeocarpus tuberculatus	11	0.05	2.20	2.50	2.39	1.63
Dysoxylum malabaricum	16	0.08	1.00	8.00	3.47	5.24
Albizzia lebbeck	3	0.01	1.00	1.50	0.65	0.98
Unidentified	3	0.01	1.00	1.50	0.65	0.98
Unidentified	1	0.01	1.00	0.50	0.21	0.32
Calophyllum inophyllum	5	0.02	1.66	1.50	1.08	0.98
Holigarna fragrans	6	0.03	1.50	2.00	1.30	1.31
Polyalthia fragrans	11	0.05	1.57	3.50	2.39	2.29
Mesua ferrea	16	0.08	1.23	6.50	3.47	4.26
Unidentified	2	0.01	1.00	1.00	0.43	0.65
Nothapodytes foetida	3	0.01	1.00	1.50	0.65	0.98
Unidentified	1	0.01	1.00	0.50	0.21	0.32
Terminalia sp.	1	0.01	1.00	0.50	0.21	0.32
Phoebe malabarica	5	0.02	1.00	2.50	1.08	1.63
Ficus sp.	2	0.01	1.00	1.00	0.43	0.65
Unidentified	3	0.01	1.00	1.50	0.65	0.98
Unidentified	1	0.01	1.00	0.50	0.21	0.32
Garcinia gummi-gutta	1	0.01	1.00	0.50	0.21	0.32
Unidentified	1	0.01	1.00	0.50	0.21	0.32

TABLE 2
ABUNDANCE OF TREE SPECIES AT MUKKALI (TROPICAL MOIST DECIDUOUS FOREST)

Species	No. of individuals	D	Ab	% F	RD	RF
Grewia tiliaefolia	32	0.32	1.10	29	12.50	13.18
Albizzia lebbeck	49	0.49	1.08	45	19.14	20.45
Dalbergia latifolia	27	0.27	1.12	24	10.54	10.90
Bambusa bambos	11	0.11	1.00	11	4.29	5.00
Bombax ceiba	5	0.05	1.00	5	1.95	2.27
Sapindus laurifolius	1	0.01	1.00	1	0.39	0.45
Terminalia paniculata	39	0.39	1.30	30	15.23	13.63
Emblica officinalis	7	0.07	1.00	7	2.73	3.18
Xylia xylocarpa	5	0.05	1.00	5	1.95	2.27
Pterocarpus marsupium	2	0.02	1.00	2	0.78	0.90
Ficus racemosa	7	0.07	1.00	7	2.73	3.18
Terminalia bellerica	1	0.01	1.00	1	0.39	0.45
Lagerstroemia microcarpa	6	0.06	1.20	5	2.34	2.27
Cassia fistula	2	0.02	1.00	2	0.78	0.90
Tetrameles nudiflora	1	0.01	1.00	2	0.39	0.45
Terminalia chebula	16	0.16	1.45	11	6.25	5.00
Haldina cordifolia	1	0.01	1.00	1	0.39	0.45
Scleichera oleosa	3	0.03	1.00	3	1.17	1.36
Spondias sp.	2	0.02	1.00	2	0.78	0.90
Erythrina stricta	6	0.06	1.20	5	2.34	2.27
Macaranga sp.	1	0.01	1.00	1	0.39	0.45
Others	32	0.37	1.45	22	12.50	10.00

TABLE 3
ABUNDANCE OF TREE SPECIES AT MUKKALI (COFFEE ESTATE)

Species	No. of individuals	D	Ab	% F	RD	RF
Terminalia paniculata	49	0.49	1.25	39	15.75	15.61
Grevillea robusta	47	0.47	1.38	34	15.11	14.34
Dalbergia latifolia	31	0.31	1.29	24	9.96	10.12
Kydia calycina	1	0.01	1.00	1	0.32	0.42
Pterocarpus marsupium	2	0.02	1.00	2	0.64	0.84
Xylia xylocarpa	16	0.16	1.45	11	5.14	4.66
Terminalia bellerica	10	0.10	1.11	9	2.21	3.79
Cassia fistula	6	0.06	1.20	5	1.92	2.10
Albizzia lebbeck	25	0.25	1.31	19	8.03	8.01
Grewia tiliaefolia	24	0.24	1.33	18	7.71	7.59
Lagerstroemia sp.	15	0.15	1.00	15	4.82	6.32
Eucalyptus sp.	1	0.01	1.00	1	0.32	0.42
Erythrina stricta	37	0.37	1.85	20	11.89	8.43
Carica papaya	2	0.02	1.00	2	0.64	0.84
Ficus racemosa	4	0.04	1.00	4	1.28	1.68
Terminalia chebula	10	0.10	1.11	9	3.21	3.79
Bambusa bambos	2	0.02	1.00	2	0.64	0.84
Schleichera oleosa	1	0.01	1.00	2	0.32	0.42
Bauhinia sp.	1	0.01	1.00	1	0.32	0.42
Emblica officinalis	1	0.01	1.00	1	0.32	0.42

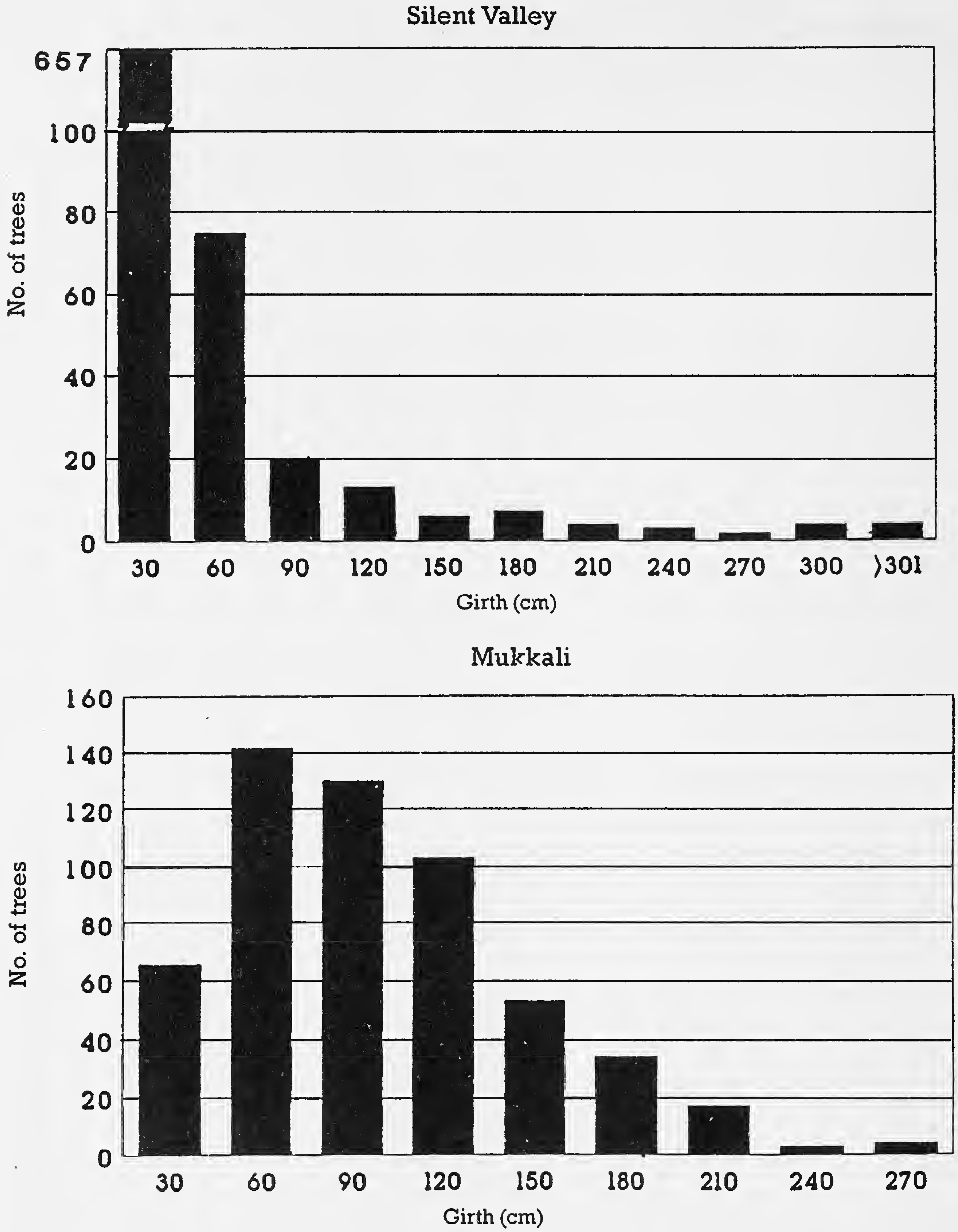

Fig. 5: Girth class distribution of trees at Silent Valley and Mukkali

and that of the estate was 11.28. Shannon-Wener diversity index of trees at Mukkali was 2.57.

Occurrence of bird species: *Silent Valley*: Ninety-nine taxa from 10 Orders and 31 Families were recorded from Silent Valley. Occurrence of birds in different months over the study period is given in Table 4. Six species were recorded in all the months, namely blossom-headed parakeet

TABLE 4
OCCURRENCE OF BIRDS AT SILENT VALLEY IN DIFFERENT MONTHS (1988-1993)

Sl. No.	Species	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
42	*Ardeola grayii* *	P	-	P	-	P	P	-	-	-	-	-	-
124	*Elanus caeruleus*	P	P	P	-	-	-	-	P	-	-	-	-
135	*Haliastur indus* *	-	-	P	-	-	-	-	-	-	P	-	-
139	*Accipiter badius* *	-	-	P	-	-	-	P	-	-	-	P	-
172	*Ictinaetus malayensis*	P	-	-	P	P	P	-	-	P	-	P	P
196	*Spilornis cheela*	-	-	P	-	P	-	-	P	-	P	P	-
211	*Falco* sp.	-	-	-	-	-	-	-	-	-	-	P	P
263	*Perdicula erythrorhyncha**	P	P	P	P	P	P	P	P	-	-	-	P
275	*Galloperdix spadicea**	-	-	P	-	-	-	-	P	-	-	P	-
301	*Gallus sonneratii*	P	P	P	P	P	P	P	-	P	P	P	P
496	*Treron pompadora*	P	-	P	P	P	-	-	-	-	-	-	-
503	*Treron phoenicoptera**	P	-	P	-	P	-	-	-	-	-	P	P
506	*Ducula aenea*	P	-	-	-	-	-	-	-	-	-	-	-
510	*Ducula badia**	P	P	P	P	-	-	-	P	-	-	-	-
516	*Columba livia**	-	-	P	-	-	-	-	-	-	-	-	-
521	*Columba elphinstonii**	-	P	-	-	-	-	-	-	-	-	-	-
537	*Streptopelia chinensis*	-	-	-	-	-	-	-	-	-	-	-	P
542	*Chalcophaps indica**	P	-	P	P	-	-	-	-	-	-	P	P
550	*Psittacula krameri*	P	-	P	-	P	P	-	P	P	P	P	P
558	*Psittacula cyanocephala*	P	P	P	P	P	P	P	P	P	P	P	P
564	*Psittacula columboides*	P	-	P	P	-	-	P	P	-	-	P	P
566	*Loriculus vernalis*	P	-	P	-	-	-	-	P	-	P	P	P
569	*Clamator coromandus*	-	-	-	-	-	-	-	P	-	-	-	-
600	*Centropus sinensis*	-	-	P	-	-	-	-	-	-	-	-	-
664	*Asio flammeus*	-	-	P	-	-	-	-	-	-	-	-	-
692	*Zoonavena sylvatica*	-	P	-	-	-	-	-	P	-	-	-	P
712	*Harpactes fasciatus*	-	-	P	-	-	-	-	-	-	-	-	-
744	*Merops leschenaulti*	P	-	-	P	-	-	-	P	-	-	-	P
768	*Ocyceros griseus*	P	P	P	-	-	P	P	-	P	-	-	P
776	*Buceros bicornis*	-	P	-	-	-	P	-	-	-	-	-	-
785	*Megalaima viridis*	P	P	P	P	P	P	-	P	P	P	P	P
798	*Picumnus innominatus*	-	-	-	-	-	-	-	P	P	-	-	-
821	*Dinopium benghalense*	P	P	P	P	P	P	P	P	P	P	P	P
825	*Dinopium javanense*	P	P	-	P	-	-	-	-	-	-	-	-
830	*Dryocopus javensis**	P	-	-	P	P	-	-	-	-	-	-	-
856	*Hemicircus canente*	-	-	-	P	P	P	-	-	-	-	-	-
867	*Pitta brachyura*	P	P	-	-	-	-	-	-	-	-	-	P
919	*Hirundo tahitica*	P	-	P	P	-	-	-	-	-	-	P	P
923	*Hirundo daurica*	P	P	P	P	P	P	-	P	P	P	P	P
949	*Lanius cristatus*	P	-	-	-	-	-	-	-	-	-	-	-
952	*Oriolus oriolus*	P	-	-	-	-	-	-	-	-	-	-	-
954	*Oriolus chinensis**	P	-	-	-	-	-	-	-	-	-	-	P
958	*Oriolus xanthornus*	P	-	P	-	-	-	-	-	-	-	-	-
963	*Dicrurus macrocercus*	P	P	P	P	P	-	-	P	-	P	P	P
967	*Dicrurus caerulescens**	-	-	-	-	-	-	-	-	-	-	P	P
971	*Dicrurus aeneus*	-	P	-	-	-	-	-	-	-	P	P	-
977	*Dicrurus paradiseus*	P	P	P	P	P	P	P	P	P	-	P	P
1006	*Acridotheres tristis*	-	-	-	-	P	-	-	-	-	-	-	-
1015	*Gracula religiosa*	P	P	P	P	P	P	-	-	P	-	P	P
1032	*Dendrocitta vagabunda*	-	-	-	-	-	-	-	-	P	-	-	-

TABLE 4 (CONTD.)
OCCURRENCE OF BIRDS AT SILENT VALLEY IN DIFFERENT MONTHS (1988-1993)

Sl. No.	Species	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
1034	*Dendrocitta leucogastra*	P	P	P	P	P	P	P	P	P	P	P	P
1054	*Corvus macrorhynchos*	-	-	P	-	-	-	-	-	-	-	-	-
1081	*Pericrocotus flammeus*	P	-	P	P	P	P	P	P	P	P	P	P
1098	*Aegithina tiphia*	-	-	-	P	-	-	-	-	-	-	-	-
1103	*Chloropsis aurifrons*	P	-	-	P	-	-	-	-	-	-	-	-
1109	*Irena puella*	-	-	-	P	-	-	-	-	-	-	-	
1116	*Pycnonotus melanicterus*	-	-	-	-	-	-	-	-	-	-	P	-
1120	*Pycnonotus jocosus*	P	P	P	P	P	P	P	P	P	P	-	P
1128	*Pycnonotus cafer*	-	-	P	-	-	-	P	P	-	-	P	P
1144	*Iole indicus*	P	P	P	P	P	P	P	P	P	P	P	P
1148	*Hypsipetes leucocephalus*	P	P	P	P	-	-	-	-	P	-	P	P
1154	*Pellorneum ruficeps*	-	-	P	-	-	-	P	-	-	-	-	-
1174	*Pomatorhinus schisticeps*	P	-	-	P	P	-	-	-	-	-	-	-
1224	*Rhopocichla atriceps**	-	-	-	-	-	-	-	P	P	-	-	-
1259	*Turdoides subrufus*	-	-	-	-	-	-	-	-	-	-	-	P
1265	*Turdoides striatus*	P	P	P	P	P	P	P	P	P	P	P	P
1267	*Turdoides affinis*	-	P	-	-	-	-	-	-	-	-	-	-
1407	*Muscicapa daurica**	-	-	P	-	-	-	-	-	-	-	-	-
1408	*Muscicapa muttui*	-	-	-	-	-	-	P	-	-	-	-	-
1435	*Cyornis pallipes**	-	-	-	-	-	-	-	-	-	-	P	-
1442	*Cyornis tickelliae*	P	P	P	-	P	-	-	-	-	-	-	P
1446	*Eumyias albicaudata**	-	-	-	-	-	-	-	-	-	-	-	P
1461	*Terpsiphone paradisi*	P	-	-	-	-	-	-	-	-	-	P	-
1601	*Phylloscopus* sp.	P	P	-	-	P	P	-	-	P	-	P	P
1661	*Copsychus saularis*	-	-	-	-	P	-	-	-	-	-	-	-
1700	*Saxicola caprata*	P	P	P	P	P	P	P	P	P	-	P	P
1728	*Myiophonus horsfieldii*	P	P	P	P	P	P	P	P	P	P	-	P
1733	*Zoothera citrina*	P	P	-	-	-	-	-	-	-	-	P	P
1752	*Turdus merula*	P	-	-	P	-	P	-	-	-	-	P	P
1794	*Parus major*	-	-	-	-	P	-	-	-	-	-	-	-
1809	*Parus xanthogenys*	-	-	P	P	P	P	P	-	-	-	P	-
1838	*Sitta frontalis*	-	-	-	P	P	P	-	-	-	-	-	-
1852	*Anthus novaeseelandiae**	P	-	-	-	-	-	-	-	-	-	-	-
1874	*Dendronanthus indica*	-	-	-	P	-	-	-	-	-	-	-	-
1876	*Motacilla flava*	P	P	P	-	-	-	-	-	P	P	P	P
1884	*Motacilla cinerea**	-	-	-	-	-	-	-	-	-	-	P	-
1892	*Dicaeum agile**	-	-	-	-	-	-	-	-	-	P	-	-
1899	*Dicaeum erythrorhynchos**	P	-	P	-	P	P	-	P	P	-	P	-
1908	*Nectarinia zeylonica*	-	-	-	-	-	-	-	-	P	-	-	-
1909	*Nectarinia minima*	P	P	P	P	-	P	P	P	P	P	P	P
1912	*Nectarinia lotenia*	-	-	-	-	-	-	-	-	P	P	-	-
1931	*Arachnothera longirostra*	-	P	P	P	P	-	-	-	-	-	-	-
1933	*Zosterops palpebrosus*	-	-	-	P	P	P	-	P	P	-	P	-
1966	*Lonchura malabarica*	P	-	-	-	-	-	-	-	-	-	-	-
1973	*Lonchura kelaarti*	-	-	-	-	-	-	-	-	P	-	-	-
1974	*Lonchura punctulata**	-	-	-	-	-	-	-	-	-	-	-	P
1978	*Lonchura malacca*	P	-	-	-	-	-	-	P	-	-	-	P
2013	*Carpodacus erythrinus*	P	P	P	-	-	-	-	-	-	-	-	P

* = Recorded only from Silent Valley, P = Present; (-) Not recorded
Serial numbers correspond to the Handbook of Ali and Ripley (1983).

(*Psittacula roseata*), lesser golden-backed woodpecker (*Dinopium benghalense*), white-bellied treepie (*Dendrocitta leucogastra*), yellow-browed bulbul (*Iole indica*) and Malabar whistling-thrush (*Myiophonus horsfieldii*). The most common species found at Silent Valley was the yellow-browed bulbul followed by the white-cheeked barbet (*Megalaima viridis*), pied bushchat (*Saxicola caprata*) and common hill-myna (*Gracula religiosa*). The Commonness and Dominance Index of 10 selected species at Silent Valley is given in Table 5. The dominant species in the community at Silent Valley were yellow-browed bulbul, black-crested bulbul (*Pycnonotus melanicterus*), common hill-myna, jungle babbler (*Turdoides striatus*) and pied bushchat. Thirty species recorded only from the Silent Valley are indicated with an asterisk in Table 4. Eight endemic species restricted to the Western Ghats: Nilgiri wood-pigeon (*Columba elphinstonii*), bluewinged parakeet (*Psittacula columboides*), Malabar grey hornbill (*Ocyceros griseus*), Indian scimitar-babbler (*Pomatorhinus schisticeps*), Nilgiri flycatcher (*Eumyias albicaudata*), whitebellied blue flycatcher (*Cyornis pallipes*), small sunbird (*Nectarinia minima*) and white-bellied treepie were recorded from the area. Among these, the Nilgiri wood pigeon is a globally threatened species. Number of individuals of each species recorded from the transect is given in Appendix 1.

TABLE 5
COMMONNESS AND DOMINANCE INDEX OF SELECTED SPECIES AT SILENT VALLEY (TROPICAL EVERGREEN FOREST)

No.	Species	Commonness Index	Dominance Index
1.	*Hypsipetes indicus*	6.29	20.33
2.	*Hypsipetes leucocephalus*	1.32	9.27
3.	*Gracula religiosa*	1.44	8.04
4.	*Saxicola caprata*	1.44	4.29
5.	*Megalaima viridis*	1.78	4.19
6.	*Pycnonotus jocosus*	1.18	3.38
7.	*Myiophonus horsfieldii*	0.98	1.92
8.	*Gallus sonneratii*	0.96	2.00
9.	*Dendrocitta leucogastra*	0.83	1.63
10.	*Dinopium benghalense*	0.81	1.52

Mukkali: Ninety-six taxa from 10 Orders and 30 Families were recorded from Mukkali. Monthly distribution of various species is given in Table 6. Seven species, namely spotted dove *Streptopelia chinensis*, white-cheeked barbet (*Megalaima viridis*) lesser golden-backed woodpecker, greater racket-tailed drongo (*Dicrurus paradiseus*), red-whiskered bulbul, redvented bulbul (*Pycnonotus jocosus*) and jungle babbler were recorded in all the months. The most common species were the black drongo (*Dicrurus macrocercus*), white-cheeked barbet, jungle babbler, redvented bulbul and greater racket-tailed drongo. Jungle babbler, red-whiskered bulbul and black drongo were the most dominant species. The Dominance and Commonness Index of 10 selected species is given in Table 7. Twenty-one species recorded only from Mukkali are marked with an asterisk in Table 6. Altogether 137 taxa of birds were recorded from both the vegetation types in this study. Number of individuals, from the transect, in each species is given in Appendix I.

Changes in bird species richness: Distinct changes in the species composition was recorded among the birds of the Silent Valley and Mukkali over different months. During the monsoon months, the number of species present in Silent Valley was low. But as the rain stopped, new species arrived and a maximum of fifty-five species were recorded in January (Table 8). Reduction in species richness during the monsoon season was observed throughout the study period. Similarly, a surge in species richness was recorded during summer, in all the years. A similar trend was observed in Mukkali. No significant difference in bird species richness, between years in monsoon ($X^2 = 4.28$; $P=<0.05$) and summer ($X^2=8.92$; $P=<0.05$) was seen at Silent Valley. But at Mukkali, a significant difference was observed between years in monsoon ($X^2 = 38.97$*; $P=<0.001$) and summer ($X^2 = 14.64$; $P=<0.001$) seasons.

TABLE 6
OCCURRENCE OF BIRDS AT MUKKALI IN DIFFERENT MONTHS (1988-1993)

S. No.	Species	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
124	*Elanus caeruleus*	P	-	-	P	-	P	P	-	P	P	P	P
139	*Accipiter badius*	-	-	-	P	-	-	-	-	-	-	-	-
172	*Ictinaetus malayensis*	-	-	P	-	-	-	-	-	-	P	-	-
196	*Spilornis cheela*	-	-	-	-	-	P	-	-	-	-	-	P
211	*Falco* sp.	-	-	-	-	-	-	-	-	P	-	-	-
301	*Gallus sonneratii*	P	P	P	P	P	-	-	-	P	P	P	P
496	*Treron pompadora*	-	-	-	-	P	-	-	-	-	-	-	-
537	*Streptopelia chinensis*	P	P	P	P	P	P	P	P	P	P	P	P
550	*Psittacula krameri*	P	P	P	P	P	P	P	-	P	P	P	P
558	*Psittacula cyanocephala*	P	P	P	P	-	-	-	-	P	P	P	P
564	*Psittacula columboides*	-	P	P	P	-	-	-	-	-	-	-	-
566	*Loriculus vernalis*	-	P	P	P	P	P	-	-	-	-	-	-
573	*Hiercoccyx varius**	-	-	-	-	P	-	-	-	-	-	-	-
590	*Eudynamys scolopacea**	-	-	P	-	-	-	-	-	-	-	-	-
600	*Centropus sinensis*	-	-	-	-	P	-	-	-	-	-	-	P
636	*Glaucidium radiatum*	-	-	P	P	-	-	-	-	-	-	-	P
664	*Asio flammeus*	-	P	-	-	-	-	-	-	-	-	-	-
712	*Harpactes fasciatus*	-	-	P	-	-	-	-	-	P	-	P	-
736	*Halcyon smyrnensis**	-	-	P	P	-	P	P	-	-	-	P	P
744	*Merops leschenaulti*	-	-	-	P	P	-	-	-	-	-	P	P
763	*Upupa epops**	-	-	P	-	-	P	-	-	-	-	-	P
768	*Ocyceros griseus*	-	-	-	P	-	P	P	-	-	-	-	P
776	*Buceros bicornis*	-	-	-	-	-	P	-	-	-	-	-	-
785	*Megalaima viridis*	P	P	P	P	P	P	P	P	P	P	P	P
815	*Picus chlorolophus**	-	-	-	-	-	P	-	-	-	-	-	-
825	*Dinopium javanense*	-	-	P	-	-	-	-	P	P	-	-	P
826	*Dinopium benghalense*	P	P	P	P	P	P	P	P	P	P	P	P
856	*Hemicircus canente*	-	-	P	P	-	-	-	P	-	-	P	P
867	*Pitta brachyura*	-	P	P	-	-	-	-	-	-	-	-	-
919	*Hirundo tahitica*	P	P	P	-	P	-	-	P	-	-	P	P
923	*Hirundo daurica*	-	-	-	-	-	P	-	-	-	-	-	-
933	*Lanius excubitor**	-	-	P	-	-	-	-	-	-	-	-	-
940	*Lanius vittatus**	-	-	P	-	P	P	-	-	-	-	-	-
946	*Lanius schach**	P	P	-	-	-	-	-	-	-	-	-	-
952	*Oriolus oriolus*	-	P	-	-	-	-	-	-	-	-	-	-
958	*Oriolus xanthornus*	-	P	P	P	P	P	-	-	P	-	P	-
963	*Dicrurus macrocercus*	P	P	P	P	P	P	P	-	P	P	P	P
971	*Dicrurus aeneus*	P	P	-	P	-	P	P	P	P	P	P	-
973	*Dicrurus hottentottus**	-	-	-	-	P	-	-	-	-	-	-	-
977	*Dicrurus paradiseus*	P	P	P	P	P	P	P	P	P	P	P	P
1006	*Acridotheres tristis*	P	P	P	P	P	-	-	-	-	-	-	-
1009	*Acridotheres fuscus*	-	P	P	-	P	-	-	-	-	-	-	-
1015	*Gracula religiosa*	P	P	-	-	P	P	-	-	-	-	-	-
1032	*Dendrocitta vagabunda*	P	-	P	P	P	-	P	P	P	P	P	-
1034	*Dendrocitta leucogastra*	P	-	P	-	P	P	P	-	P	-	P	-
1049	*Corvus splendens**	-	P	-	-	P	-	P	-	P	-	P	-
1054	*Corvus macrorhynchos*	P	-	P	-	-	-	-	-	-	-	-	-
1077	*Coracina melanoptera**	-	-	P	-	-	-	-	-	P	-	-	-
1081	*Pericrocotus flammeus*	P	-	P	P	-	P	P	-	P	P	P	P

TABLE 6 (CONTD.)
OCCURRENCE OF BIRDS AT MUKKALI IN DIFFERENT MONTHS (1988-1993)

S. No.	Species	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
1098	*Aegithina tiphia*	P	P	P	-	-	P	-	-	-	-	-	-
1103	*Chloropsis aurifrons*	P	-	P	P	-	P	P	-	P	-	P	P
1108	*Chloropsis cochinchinensis**	-	P	-	-	P	-	-	-	-	P	-	-
1109	*Irena puella*	-	-	-	P	-	P	-	-	-	-	-	-
1116	*Pycnonotus melanicterus gularis*	-	-	P	P	-	-	-	P	-	-	-	-
1120	*Pycnonotus jocosus*	P	P	P	P	P	P	P	P	P	P	P	P
1128	*Pycnonotus cafer*	P	P	P	P	P	P	P	P	P	P	P	P
1144	*Hypsipetes indicus*	P	P	P	P	-	P	P	P	P	P	P	P
1148	*Hypsipetes leucocephalus*	P	-	P	-	-	P	-	-	P	P	P	P
1174	*Pomatorhinus schisticeps*	-	-	-	-	-	-	-	-	-	P	-	-
1259	*Turdoides subrufus*	-	P	-	-	-	-	-	-	-	P	-	-
1265	*Turdoides striatus*	P	P	P	P	P	P	P	P	P	P	P	P
1267	*Turdoides affinis*	P	-	P	P	P	P	-	-	-	P	P	-
1407	*Muscicapa latirostris*	-	P	-	-	-	-	-	-	P	-	P	-
1408	*Muscicapa muttui*	P	-	-	-	-	-	-	-	-	-	-	-
1409	*Muscicapa ruficauda**	P	-	-	-	-	-	-	-	-	-	-	-
1427	*Ficedula nigrorufa* *	P	-	-	-	-	-	-	-	-	-	-	-
1445	*Eumyias thalassina**	P	-	-	-	-	-	-	-	-	-	-	-
1461	*Terpsiphone paradisi*	-	-	P	-	-	-	-	-	-	-	-	P
1538	*Orthotomus sutorius*	-	-	-	P	P	-	-	-	-	P	P	-
1601	*Phylloscopus* sp.	P	P	-	-	P	-	-	-	-	P	P	-
1661	*Copsychus saularis*	P	P	P	P	P	P	P	-	P	-	P	P
1700	*Saxicola caprata*	P	P	P	-	-	P	-	P	P	P	P	P
1726	*Monticola solitarius*	P	P	-	-	-	-	-	P	-	-	-	-
1728	*Myiophonus horsfieldii*	-	-	P	P	-	P	P	P	-	-	P	-
1733	*Zoothera citrina*	P	-	-	-	-	-	-	-	-	-	-	-
1794	*Parus major*	P	P	-	-	-	-	-	-	-	-	-	-
1809	*Parus xanthogenys*	-	P	P	-	-	-	P	-	-	-	-	-
1838	*Sitta frontalis*	-	-	-	-	P	P	-	-	-	P	-	-
1874	*Dendronanthus indica*	P	-	P	-	-	-	-	-	-	-	-	-
1876	*Motacilla flava*	P	P	P	-	-	-	-	-	P	P	P	P
1885	*Motacilla alba**	-	-	-	-	-	-	-	-	-	P	-	-
1899	*Dicaeum erythrorhynchos*	P	P	-	-	-	-	-	-	-	-	-	P
1908	*Nectarinia zeylonica*	-	P	-	-	P	-	-	-	P	P	P	P
1909	*Nectarinia minima*	P	-	P	-	-	-	-	-	-	-	P	-
1912	*Nectarinia lotenia*	-	P	-	P	-	-	-	-	P	-	-	-
1931	*Arachnothera longirostra*	-	-	-	-	-	-	-	-	-	-	P	-
1933	*Zosterops palpebrosus*	-	P	-	-	-	P	-	-	-	-	P	-
1949	*Petronia xanthocollis**	-	P	-	-	-	-	-	-	-	-	-	-
1973	*Lonchura kelaarti*	-	-	-	-	-	P	-	-	-	-	-	-
1978	*Lonchura malacca*	P	-	-	-	-	-	P	-	P	P	-	-

* = Recorded only from Mukkali, P = Present, (-) Not recorded; Serial numbers correspond to Handbook of Ali and Ripley (1983)

DISCUSSION

Vegetation: The higher rate of recruitment of new seedlings at Silent Valley was mainly due to the protection afforded to the National Park and adjacent forests, and its distance from human settlements. Fire and tree felling appeared to have thinned this tract. One hundred and one dead trees were recorded on both sides of the transect, within a width of 10 m at Silent Valley, whereas only 10 such were recorded from Mukkali. However, at Mukkali, the forests being

TABLE 7
COMMONNESS AND DOMINANCE INDEX OF SELECTED SPECIES AT MUKKALI (MOIST DECIDUOUS FOREST)

No.	Species	Commonness Index	Dominance Index
1.	*Dicrurus macrocercus*	2.08	5.94
2.	*Megalaima viridis*	2.04	5.47
3.	*Turdoides striatus*	1.74	19.08
4.	*Pycnonotus cafer*	1.47	4.61
5.	*Dicrurus paradiseus*	1.17	3.17
6.	*Iole indicus*	0.89	3.13
7.	*Streptopelia chinensis*	0.85	2.20
8.	*Dinopium benghalense*	0.83	2.09
9.	*Copsychus saularis*	0.70	1.94
10.	*Psittacula cyanocephala*	0.68	3.42

Moist Deciduous, trees with a height of more than 30 m were less and due to selective felling in this area in earlier periods, trees of more than 270 cm GBH were few. As the quadrats assessed for percentage tree composition were on both sides of the transect line, it is quite natural that pioneer species like *Macaranga peltata* and *M. indica* were abundant in the area. This tract had a history of fire during early 1980s, i.e. before the area was declared a National Park. Maturity Index showed a lower value, which is usually obtained in the stages of succession. Diversity of tree species was high, which is correlated with the bird density.

At Mukkali, no major difference was seen in the occurrence of tree species in the forest areas and estate. Both areas had the same number of tree species.

Birds: Composition and diversity of trees have a great influence on the occurrence of birds. During this study, birds were observed 4,500 times, in which a total of 9,921 birds were counted. Of the 137 species identified from the two vegetation types, 21 migrant species were from Silent Valley and 11 were from Mukkali; others were residents. Fifty-six species were common to both the vegetation types, while 30 species were found only in the Evergreen and 21 only in the Moist Deciduous Forest. This indicates the importance of Evergreen forests in the conservation of birds. Most of the species showed only local movements. The migrants, which were recorded from Silent Valley, were the wagtails (*Motacilla* sp.), common rosefinch (*Carpodacus erythrinus*) and red-winged crested cuckoo (*Clamator coromandus*). Distinct changes in species composition were recorded among the birds of the Silent Valley and Mukkali over different months. During monsoon, the number of species present in the Silent Valley was low.

TABLE 8
MONTHLY VARIATION IN THE BIRD SPECIES RICHNESS AT SILENT VALLEY AND MUKKALI (MEAN)

Area	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
Silent Valley	55	42	46	34	40	23	26	27	34	21	39	42
Mukkali	46	36	53	44	29	43	25	17	33	28	38	27

Most of the doves, pigeons, parakeets and black bulbuls (*Hypsipetes madagascariensis*) were not recorded in the monsoon at Silent Valley, but were seen returning to the area with the retreat of the rain. The yellow-browed bulbul is the most common and dominant species at Silent Valley. The second common species, the white-cheeked barbet comes only sixth in dominance. From the Dominance Index, it is clear that barring a few species, all are very rare. Due to the heavy mist and low activity of birds during monsoon, it was difficult to detect them, which may be one reason for the lower numbers recorded. Also, local movement of species like the black bulbul to the Evergreen Forest was observed during summer.

A major difference between the two bird communities lay in the composition of the bird species. The study suggests that the high diversity index of vegetation is an indication of increased bird density in tropical forests (Table 9). More unique and endemic species were recorded from the Evergreen Forest, which showed the influence of vegetation on species

TABLE 9
COMPARISON OF BIRD COMMUNITY PARAMETERS WITH DIVERSITY INDICES OF VEGETATION

Areas	Vegetation indices		Bird community parameters			
	Maturity Index	Diversity Index H'	Species Richness	Density*	Diversity Index H'*	Endemic Species
Silent Valley	2.85	2.91	99	1,122/km²	3.30	8
Mukkali	10.00	2.57	96	780/km²	3.45	4

*Jayson and Mathew (2000a)

composition of birds. It seems that rare species like the great pied hornbill (*Buceros bicornis*) and the great black woodpecker (*Dryocopus javensis*) were affected severely during the pre-survey period of the abandoned hydroelectric project, because most of the dry trees were burnt for firewood and the great pied hornbill was hunted for its flesh (Vijayan and Balakrishnan 1977). Presence of endemic and globally threatened species showed the conservation value of Tropical Evergreen forests at Silent Valley.

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APPENDIX 1

TOTAL NUMBER OF EXAMPLES SEEN IN EACH BIRD SPECIES AT SILENT VALLEY AND MUKKALI

Species	Abundance		Species	Abundance	
	Silent Valley	Mukkali		Silent Valley	Mukkali
Hypsipetes indicus	1070	87	*Hirundo domicola*	180	-
Hypsipetes madagascariensis	488	48	*Pycnonotus jocosus*	178	172
Gracula religiosa	423	25	*Psittacula krameri*	147	63
Turdoides striatus	240	530	*Dicrurus adsimilis*	128	165
Saxicola caprata	226	39	*Gallus sonneratii*	105	26
Nectarinia minima	222	4	*Lonchura malacca*	104	32
Megalaima viridis	221	152	*Myiophonus horsfieldii*	101	13

Appendix 1 (contd.)

TOTAL NUMBER OF EXAMPLES SEEN IN EACH BIRD SPECIES AT SILENT VALLEY AND MUKKALI

Species	Abundance		Species	Abundance	
	Silent Valley	Mukkali		Silent Valley	Mukkali
Zosterops palpebrosus	101	50	*Copsychus saularis*	3	-
Dendrocitta vagabunda	86	26	*Chloropsis aurifrons*	3	55
Dinopium benghalense	80	58	*Haliastur indus*	2	-
Carpodacus erythrinus	79	-	*Columba livia*	2	-
Perdicula erythrorhyncha	75	-	*Cyornis pallipes*	2	-
Pomatorhinus schisticeps	69	2	*Nectarinia zeylonica*	2	41
Pericrocotus flammeus	58	73	*Zoonavena sylvatica*	2	-
Parus xanthogenys	55	20	*Ducula aenea*	2	7
Psittacula cyanocephala	52	95	*Lanius* sp.	2	5
Treron phoenicoptera	52	-	*Acridotheres tristis*	2	53
Dicrurus paradiseus	43	88	*Turdus merula*	2	12
Treron pompadora	41	11	*Ardeola grayii*	2	-
Cyornis tickelliae	41	-	*Falco* sp.	1	1
Psittacula columboides	35	13	*Dendrocitta vagabunda*	1	-
Motacilla flava	35	22	*Clamator coromandus*	1	-
Zoothera citrina	31	17	*Eumyias albicaudata*	1	-
Chalcophaps indica	27	-	*Dinopium javanense*	2	7
Phylloscopus sp.	27	11	*Pycnonotus melanicterus*	1	1
Ocyceros griseus	25	6	*Picumnus innominatus*	1	-
Sitta frontalis	23	4	*Rhopocichla atriceps*	1	-
Ducula badia	18	-	*Anthus hodgsoni*	2	-
Dicrurus aeneus	17	19	*Hirundo* sp.	-	66
Pellorneum ruficeps	16	-	*Centropus sinensis*	1	-
Pycnonotus cafer	16	128	*Dicrurus caerulescens*	1	-
Elanus caeruleus	14	5	*Picumnus innominatus*	1	-
Loriculus vernalis	13	13	*Corvus macrorhynchos*	1	6
Arachnothera longirostra	13	1	*Aegithina tiphia*	1	6
Lonchura punctulata	13	-	*Irena puella*	1	3
Dicaeum erythrorhynchos	13	-	*Muscicapa latirostris*	1	-
Dryocopus javensis	12	-	*Asio flammeus*	1	1
Ictinaetus malayensis	11	2	*Harpactes fasciatus*	1	2
Hirundo daurica	11	1	*Muscicapa muttui*	1	2
Buceros bicornis	11	1	*Streptopelia chinensis*	-	61
Streptopelia chinensis	9	-	*Eudynamys scolopacea*	-	3
Nectarinia lotenia	8	9	*Halcyon smyrnensis*	-	7
Lonchura malabarica	8	-	*Upupa epops*	-	2
Terpsiphone paradisi	8	3	*Picus chlorolophus*	-	10
Hemicircus canente	7	6	*Lanius vittatus*	-	9
Turdoides affinis	7	42	*Dicrurus hottentottus*	-	1
Columba elphinstonii	7	-	*Acridotheres fuscus*	-	7
Spilornis cheela	6	5	*Corvus splendens*	-	47
Oriolus oriolus	6	1	*Chloropsis cochinchinensis*	-	12
Turdoides subrufus	4	14	*Ficedula nigrorufa*	-	1
Motacilla cinerea	4	-	*Eumyias thalassina*	-	1
Dicaeum agile	4	-	*Dendronanthus indica*	-	5
Oriolus chinensis	4	-	*Orthotomus sutorius*	-	5
Galloperdix spadicea	4	-	*Monticola solitarius*	-	18
Parus major	3	13	*Petronia xanthocollis*	-	1
Merops leschenaulti	3	9			
Accipiter badius	3	1			

- = Not recorded

INDIVIDUAL VARIATION AND SEXUAL DIMORPHISM IN *THAMNOECHA UNIFORMIS* (BUTLER 1875), LEPIDOPTERA: SPHINGIDAE[1]

PETER SMETACEK[2]

Key words: Lepidoptera, Sphingidae, hawkmoths, *Thamnoecha uniformis*

Existing information about *Thamnoecha uniformis* (Butler 1875) is examined and the range of individual variation and sexual dimorphism in the species discussed.

INTRODUCTION

The hawkmoth *Thamnoecha uniformis* (Butler 1875) is a Himalayan endemic. The genus is monobasic and little is known about the species. Since the original description by Butler in 1875, only males of the species were known until Dierl (1970) described a single female from Narkanda (Himachal Pradesh).

Although Dierl (op. cit.) observed some differences between the sexes, he did not appear to have more than a single pair to hand on which he based his observations. The present study developed out of the need to place the sexes correctly without resorting to genitalic examination, a task that has caused some confusion in the past. The confusion was caused by the relatively great individual variation in such a sparingly marked species.

This moth has been recorded from Sabathu near Shimla, which is the type locality, and Narkanda in Himachal Pradesh; Katarmal and Bhimtal in Kumaon and Nagarjong and Godaveri in Nepal. It ascends to 2,700 m (Narkanda) and has been recorded from as low as 1,280 m (Katarmal). It will probably be found even lower in suitable localities, i.e. chir pine (*Pinus roxburghii* Sarg.) forests.

The larval food plant of *Thamnoecha uniformis* is thought to be chir pine by a process of elimination. Dierl (op. cit.) found a larva with the characteristic form and stripe of a conifer-feeding hawkmoth close to the *Sphinx* L. genus on chir pine in Nepal.

[1]Accepted March, 2000

[2]Jones Estate, Bhimtal, Nainital, Uttaranchal 263 136, India.

This larva was subsequently parasitised and no moth developed out of it. Since no Indian hawkmoth was known to feed on conifers and *uniformis* was, at the time, the only known representative of this group in the area, and lastly, a male *uniformis* was found by Dierl (op. cit.) in the daytime settled on a chir pine trunk in Nagarjong, it was assumed that the larva was that of *uniformis*. This has, however, not been confirmed by actual breeding experiments. Although there is little reason to doubt that chir pine is the larval food plant of *uniformis*, it is pertinent that *Sphinx ligustri* L. has been recently reported from Kumaon (Smetacek 1994). While *ligustri* is not known to feed on conifers, the point is that *uniformis* is not the only representative of the group in the western Himalaya.

In the present study, *T. uniformis* has been recorded in every month from March through August. It is always extremely scarce, no more than one individual appearing at a time. The southwest monsoon, which dictates the flying period of most hawkmoths in this area, does not perceptibly affect the emergence pattern of *uniformis*. Nor has this moth been found to be affected by climatic anomalies such as drought or unusually warm winters. It has always been very scarce, even though its presumed larval food plant, chir pine, covers vast tracts in Kumaon. It may be added that the assessment of its scarcity is based on its attendance at artificial light, rather than actual examination of chir pine forests at appropriate times.

The only factor which seems to affect populations of this moth, besides larval

parasites, is forest fire, which is an almost regular phenomenon in chir pine forests. None were recorded after major fires. However, the same can be said for all other hawkmoths and insects that happen to live in or near chir pine forests.

Both sexes are attracted to mercury vapour lamps of 125-160 W. They are active at dusk and during the early hours of darkness, almost never appearing after 2030 hrs in summer. Their activity at dawn has not been assessed. Unlike most hawkmoths that are active and nervous for some time after being attracted, both sexes of *uniformis* settle directly upon arrival and rarely change position. Usually, they select a dark surface to settle upon, but will do so on a white-washed pillar if no other convenient perch is available. They rarely settle under the glare of the lamp, preferring a shady corner. At rest, they hold their wings draped laterally over the abdomen, the short abdomen and blunt wings giving them the appearance of Notodontids rather than hawkmoths. They closely resemble the European *Sphinx pinastri* L., especially at rest. Although *pinastri* is known to visit flowers at dusk, *uniformis* has never been seen visiting flowers. The following is a description of the sexes:

Thamnoecha uniformis (Butler)

1875. *Hyloicus uniformis* Butler. *Proc. zool. Soc. Lond.*: 261.

1903. *Thamnoecha uniformis* Rothschild & Jordan. *Rev. Sphing.*:153.

Male: **Length of forewing**: 23-25 mm (*mihi*).

Expanse: 50 mm (Dierl op. cit.; Hampson 1892; Bell & Scott 1937) to 54 mm (Hampson 1892).

Forewing to antenna ratio: 1.76: 1.

Material Examined: 2 exs.: 5.vii.1989, Katarmal 1,280 m *Leg*. P. Smetacek; 21.iii.1994, Jones Estate, Bhimtal, 1,500 m *Leg*. P. Smetacek.

Diagnosis: Palpi, vertex of head, thorax and abdomen brownish-grey. The sides of head black. Vertex of thorax cinereous grey. Collar and tegulae proximally fringed with black. Antennae fasciculate, terminally swollen into a club and narrow at base. Antennae more than half the length of the forewing.

Forewing grey with a proximally curved ferruginous medial band and two similar postmedial bands. The bands are distinctly marked in some individuals, nearly obsolete in others. One prominent black streak in the interspace between veins 2 (Cu_2) and 3 (Cu_1) and another above it in the interspace between veins 4 (M_3) and 3 (Cu_1). Rarely, there is a short black streak in the interspace between veins 5 (M_2) and 4 (M_3) as in the Nepalese specimen figured by Allen (1993). These marks are variable, one or the other might be longer or more heavily marked or one might be altogether obsolete. Dark points on the cilia at the veins. Hindwing reddish-brown, cilia grey. The *verso* surface is uniform grey, the cilia as on the *recto* surface except that on the hindwing, there are faint dark points discernible at the veins.

In the Katarmal specimen, the medial area of the forewing *recto*, between the rufous bands, is darker than the rest of the wing.

Female: **Length of forewing**: 23 - 29 mm (*mihi*).

Expanse: 53 mm (Dierl op. cit.) to 66 mm (*mihi*).

Forewing to antenna ratio: 2.15: 1 to 2.4: 1.

Material Examined: 6 exs.: 2.vi.1974; 18.v.1989; 6.iv.1982; 5.vi.1998; 22.viii.1997, all collected at Jones Estate, Bhimtal, 1,500 m, Coll. P. Smetacek; 7.vi.1925 Bhimtal, Maxwell Coll., BM 1967-553 (Coll. Natural History Museum, London) (Photograph of *recto* surface examined)

Diagnosis: Palpi pale grey, sometimes nearly white, contrasting with the rest of the

head. Vertex of head, vertex of thorax and abdomen grey. Collar and tegulae brownish-grey and defined proximally by a narrow black fringe. Antennae simple, narrow, terminally swollen into a prominent club, the tip tapering to a point but not hooked. Antennae less than half the length of the forewing.

Forewing uniformly grey, the inner area faintly ferruginous or darker grey. Traces of one medial and two postmedial ferruginous bands on the costa of some individuals. These bands never reach below vein 4 (M_3). The two black streaks in the interspaces between vein 4 (M_3) and vein 2 (Cu_2) are usually faint and often one or both are entirely obsolete. Cilia of forewing with prominent dark points at the veins. Hindwing uniformly brownish-grey in some individuals, grey in others. *Verso* surface uniformly grey with a fine marginal dark line to both wings.

Discussion

From the above, it is evident that there are modest but consistent differences between the sexes, both in the external structure as well as in the pattern. The structure and length of the antennae are the most evident external structural differences. Dierl (1970) noted that the antennae of the female are thinner than those of the male. This is due to the fascicles on the male's antennae rather than their actual thickness, which is more or less the same as those of the female. Dierl also stated that the antennae of the female are shorter than the male, reaching only a little over half the length of the forewing costa. In the specimens examined in the present study, the antennae of the female are less than half the length of the forewing costa, while those of the male are more than half the length of the forewing costa.

Contrary to Dierl's (op. cit.) observation, size is not a distinguishing factor between the sexes. The usual expanse given for males by most authors is 50 mm. However, in Hampson's (1892) description of *Protoparce uniformis* Butler, he gives an expanse of 54 mm for the material examined by him. Since only males were known at the time, it follows that this measurement applies to males. In the same work, Hampson described *Pseudosphinx concolor* for the first time and gave a measurement of 50 mm. *P. concolor* turned out to be a synonym of *uniformis*. Bell & Scott (1937) used Hampson's (1892) description of *concolor* in their description of *uniformis* and apparently overlooked the measurement of 54 mm given by Hampson (op. cit.) for *Protoparce uniformis*. This presumption is strengthened by the fact that *Protoparce uniformis* is not mentioned in the synonymy by Bell & Scott (op. cit.), although *Pseudosphinx concolor* is included.

It is noteworthy that in Hampson's (op. cit.) description of *Protoparce uniformis* males, there is no mention of the horizontal black streaks on the forewing *recto* between vein 2 (Cu_2) and vein 4 (M_3). Kitching (*in litt.*) notes that there are three males and four females in the collection of the Natural History Museum in London (UK). All are somewhat worn and faded, with the pattern difficult to distinguish. A specimen from this collection has been figured by D'Abrera (1986), and it is of interest that, on the basis of the characters of the antennae, the specimen is likely to be a female, not a male as stated. The specimen in the same collection from Bhimtal, of which a photograph was examined, is slightly worn, particularly on the distal half of the forewing *recto*. It lacks the horizontal black streaks on the forewing *recto*. Rothschild & Jordan (1903) note that in all the specimens examined by them, which are the three male specimens mentioned above, the tips of the antennae were broken off.

The ferruginous bands on the forewing *recto* are usually more strongly developed in males than in females. Besides this, only females appear to have the black marginal line on the *verso* surface of both wings.

The black streaks on the forewing are variable, but despite Hampson's (op. cit.) description of male *Protoparce uniformis* mentioned above, which lacks these streaks, I am of the opinion that these streaks are prominent in males, while in females, they may be present, or one or more might be absent. I have a female in good condition, which entirely lacks both the black streaks.

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PETAURISTA NOBILIS SINGHEI — FIRST RECORD IN INDIA AND A NOTE ON ITS TAXONOMY[1]

ANWARUDDIN CHOUDHURY[2]

(*With one text-figure*)

Key words: Giant flying squirrel, *Petaurista nobilis singhei*, Arunachal Pradesh, West Kameng, northeastern India, distribution

The giant flying squirrel *Petaurista nobilis singhei* is known only from Bhutan. Recently, some skins were examined and live animals observed in the wild in Arunachal Pradesh in northeastern India. This is the first record for the subspecies *singhei* in India, and the first record for the species *P. nobilis*, in northeastern India. Habitat loss and hunting are the main problems faced by the animal. Protected areas having this species are the Eaglenest Wildlife Sanctuary and Sessa Orchid Sanctuary, both in Arunachal Pradesh.

INTRODUCTION

Petaurista nobilis (Gray) is a poorly known giant flying squirrel, described from specimens obtained from Darjeeling, West Bengal. It is also found in the hills and mountains of Nepal and Sikkim (Ghose and Saha 1981). A new subspecies of *Petaurista nobilis* was described from specimens obtained in Bhutan. This new race was named *singhei* (Saha 1977). Larger size, richer colour and the absence of a pale mid-dorsal stripe distinguishes it from the nominate subspecies.

During field survey in western Arunachal Pradesh, I came across both live animals as well as many preserved skins, which happened to be first records for the subspecies in India with an eastward range extension. Locally, the Sherdukpen people call it *Khiaw*.

STUDY AREA AND METHODS

The study area covered West Kameng district (26° 56'-27° 50' N, 92° 01'-92° 56' E) of Arunachal Pradesh. The area was formerly referred to as part of the Balipara Frontier Tract of Assam, and the Kameng Frontier Tract of NEFA (Northeast Frontier Agency). The terrain is hilly and mountainous (part of the Eastern Himalaya) with elevation varying from 100 m in the south to more than 7,000 m at some of the peaks in the Great Himalaya. The field work was carried out from 100 to 4,000 m. North-south and east-west flowing rivers dissect the district, making long narrow valleys (Tenga, Rupa, Shergaon, Dirang and Sangti). The highest ranges are towards the north, while the lowest elevation is in the riverbeds near the Assam-Arunachal Pradesh border (around 100 m above msl.). The annual rainfall ranges from less than 2,000 mm in the north to more than 3,000 mm in the south.

Several field trips were made to West Kameng (November 1997, April, July, August and November 1998, July, October and December 1999, and April, May and October 2000) to study its wildlife. Some preserved skins were examined in the tribal villages, and the local villagers and hunters were also interviewed. The skins available in the village helped them to describe sightings. For direct observation, we made foot-transects along existing and new paths and trails, and vehicle-transects along roads and motorable tracks. Observations were aided with a pair of

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[2]The Rhino Foundation for Nature in NE India, c/o Assam Co. Ltd. Bamunimaidam, Guwahati 781 021, Assam, India.

10 x 50 binoculars and 10 x 46 telescope. Photographs were taken with a Canon T50 camera with 200 mm tele lens and a Nikon FM2.

Results

External measurements and coloration: Most of the specimens seen in different villages (skins) were examined using standard methods and photographed. The measurements are listed in Table 1. The length of head and body ranged from 47 to 69 cm while that of tail, 51 to 61 cm.

All the specimens examined have thick, woolly, glossy hair. The saddle is a rich maroon-brown. The shoulder patches extend along the sides of the body, and in some specimens may join at the lower back (behind the dark saddle). Colour varies from rich orange-buff to rich brownish-buff. Parachute varies from orange-yellow to ochraceous-brown. Tail-tip deep blackish or black. Underside light yellow-buff, almost uniform except near abdomen, which is richer. The dark saddle may join the dark area on head by a broad patch or a thin line. Mid-dorsal stripe present in one skin, but it is broken.

Distribution and Habitat: Specimens were examined at Morsing, Tenzinggang, Shergaon, Thungre, and Tenga Valley, while live animals were observed between Lamacamp and Ramalingam, just outside Eaglenest and Sessa Orchid Sanctuaries (Fig. 1). Coordinates and elevations are given in Table 1. The animals were found to occur in the wild in subtropical and temperate broadleaf forests, in the mountains from 1,500 m up to 2,300 m. The habitat near Tenzinggang nullah, from where a few were shot

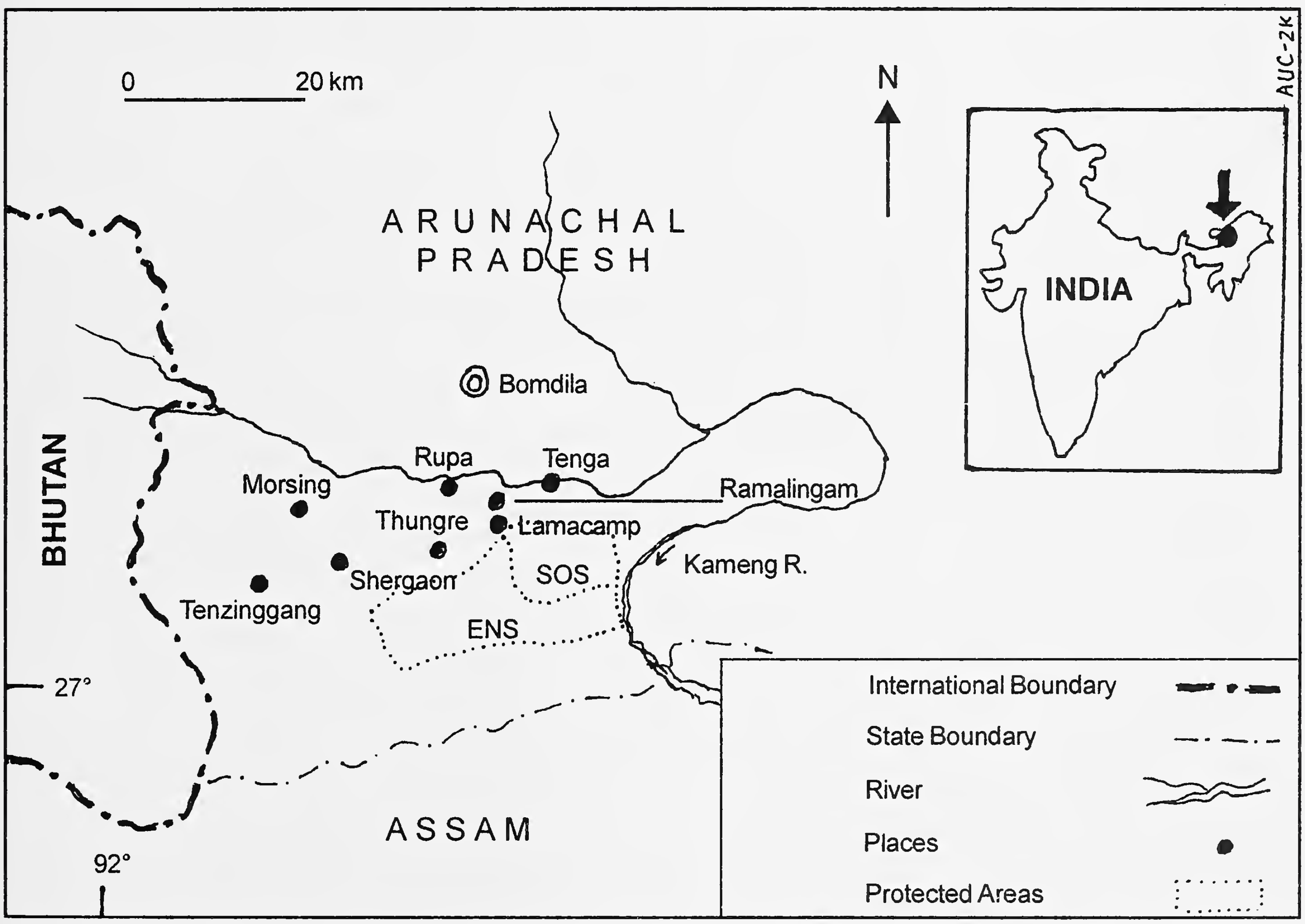

Fig. 1: Map of the study area showing the places mentioned in the text
(SOS Sessa Orchid Sanctuary, ENS Eaglenest Sanctuary)

by hunters from Shergaon, is subtropical broadleaf. It may also occur in mixed broadleaf and coniferous forests (e.g., near Tenga Valley, Thungre).

Ecology: Very little is known. Like other giant flying squirrels, *singhei* is also nocturnal. The specimens seen live, as well as those shot by local hunters, were all sighted at night. The live animals were seen feeding on the ground, on dirt road after dusk. They preferred new roadside cuttings. On examination of the feeding sites, nothing on the ground indicated that they were taking salt or minerals directly from the earth (primates and ungulates often haunt such new cuttings or slides for salt).

A squirrel feeding on the ground almost came under our vehicle. It was rather unafraid and moved away slowly. At another site, one was by the side of the road and went down as we approached.

Conservation issues: It is apparent that habitat loss and hunting for the pot are the main threats faced by *singhei.* The number of skins in just a few villages indicates that many are shot every year. Many hunters do not keep the skins. Also, there is apparently no trade, save for a few skins sold to visitors or army officials. Habitat loss is mainly due to felling. However, in view of the Supreme Court judgement, large-scale cutting has currently been stopped. In the 1980s and early 1990s, most of the forest around Rupa, Thungre, and between Rupa and Shergaon was destroyed. The habitat near Shergaon and Tenzinggang is still good. But there is no future for these areas, as the community forests have been saved temporarily by a court judgement and villagers are waiting for the clearance from the court in future. The protected areas having *singhei* are Eaglenest Wildlife Sanctuary (217 sq. km) and Sessa Orchid Sanctuary (100 sq. km).

Discussion

The range of the species is now extended eastwards by more than 100 km. This is also the first record, for India, of the subspecies *singhei* which was known only from Bhutan (Saha 1977) where it has been recorded at Gomchu Valley (*c.* 2,240-2,288 m), Paro (*c.* 2,440 m) and Mithangarh (*c.* 1,676 m). In the holotype and seven paratypes, tail length is always more than that of head and body, the difference being marginal (49:51 cm) to significant (48.7:59 cm). In the present study, in four skins, the head-body and tail were intact (Table 1). In only one case was the tail longer, while in the rest, the head and body were longer than the tail. The specimens of the present study were also larger than in previous records. The longest head and body length in Saha (1977) is given as 48.7 cm, and that of tail 59.0 cm (same specimen). In our study, all but one are larger in size (head and body max. 69 cm). However, in case of the tail only one exceeded 60.0 cm (61.0 cm). The largest specimen (overall: head-body and tail) in Saha (1977) was 107.7 cm while in the present case, it is 126.8 cm. Our records also show that there could be significant variations in the length of the tail and coloration in the species.

The nominate subspecies *P. n. nobilis* (Gray) is known from Darjeeling, Sikkim and Nepal (Ghose and Saha 1981).

The taxonomic status of *nobilis* was the subject of some controversy. The giant flying squirrels with prominent yellow shoulder patch, originally described as *Sciuropterus* [= *Petaurista*] *magnificus* Hodgson 1836, and *Sciuropterus* [=*Petaurista*] *nobilis* Gray 1842 were synonymised by most authors. Blyth (1863) treated *Petaurista nobilis* and Hodgson's giant flying squirrel *Petaurista magnificus* as conspecific, likewise Ellerman (1963), and Ellerman and Morrison-Scott (1966). However, Wroughton (1911, 1919) treated *nobilis* as a separate species, but as a race of *Petaurista albiventer* (Gray). Corbett and Hill (1992) also treated it as a separate species.

P. magnificus and *P. nobilis* have been isolated from their congenerics by the presence

Table 1
MEASUREMENTS AND DETAILS OF LOCALITIES OF *PETAURISTA NOBILIS SINGHEI*

Locally	Coordinates of Locality of Collection / Sighting	Elevation of Locality of Collection / Sighting (m above msl)	Head and body of skin (cm)	Tail (cm) (up to tip of the hair)	Remarks
Thungre	27° 07' N, 92° 25' E	1,800+	47.0	51.0	April 1999
Shergaon	27° 07' N, 92° 15' E	2,000+	62.0	(cut)	April 1999
Shergaon	27° 07' N, 92° 15' E	2,000+	59.5	57.0	April 1999
Shergaon	27° 07' N, 92° 25' E	2,000+	69.0	57 .8	Some of the Shergaon specimens were shot near Tenzinggang Nala (27° 06' N, 92° 12' E) 1500 m + elevation)
Between Lamacamp and Ramalingam	27° 09' N, 92° 27' E	2,100-2,300	-	-	2 seen live at 6-6.20 p.m. December 10, 1999
Morsing	27° 10' N, 92° 13' E	2,000+	-	-	May 2000; skin not measured
Tenga Valley	27° 11' N, 92° 30' E	1,500+	64.0	61.0	December 1999

of distinct shoulder patches. Even Ellerman (1963) concluded that the two forms were seasonal variants. One obvious reason was lack of material. Ghose and Saha (1981) showed that besides coloration, there is significant difference in the skull.

I suggest a common name "orange giant flying squirrel" for the species/subspecies.

Acknowledgements

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THE INITIAL COLONISATION OF THE YAMUNA FLOOD PLAIN BY THE SIND SPARROW *PASSER PYRRHONOTUS*[1]

Bill Harvey[2] and Suresh C. Sharma[3]

(*With two text-figures and one plate*)

Key words: *Passer pyrrhonotus*, Sind sparrow, *Acacia nilotica*, Haryana, canal, colonisation

The Sind sparrow *Passer pyrrhonotus* appears to be spreading out of its traditional range in the Indus Basin in Pakistan and extreme northwest India. Birds were found in twelve sites near canals in eastern Haryana and north Delhi during January-August 2001 and successful breeding was first proved in June. Details of the sightings, observed habits and nesting are given with descriptions of the plumage.

Introduction

The Sind sparrow *Passer pyrrhonotus* was largely restricted to the Indus flood plain in Pakistan and its tributaries just extending into Punjab, in India. It was first described in 1844, but then lost to ornithologists until 1880. It took a further 50 years for it to be fully accepted as a full species; many earlier writers considered it to be a sub-species of the house sparrow *Passer domesticus* (Summers-Smith 1988). The SYNOPSIS (Ripley 1982) describes its range as "the plains of the Indus from Nowshera (*c.* 34 °N), the Jhelum district, Gurdaspur, Ferozepore and Ludhiana ... south to Sadhani, Hyderabad (*c.* 25 °N) and the Nara canal in Sind." Summers-Smith (1988) gives more detail for its Indian range; "into the Indian Punjab on the Beas river near Gurdaspur and along the Sutlej to Ladhowai (10 km north of Ludhiana)" and "found it regular along the Sutlej from Harike, east to the bridge on the main road between Ludhiana and Jullunder (Jalandhar), but not further upstream at Rupar." There are old records from Baluchistan and neighbouring Iran (Summers-Smith 1988). Bapat (1993) records sightings in 1990 from Khari Nadi, *c.* 3 km west of Bhuj in Kutch, Gujarat, but gives very little detail. With our present knowledge of range and habitat requirements, this report requires substantiation. Apparently, the species has had a restricted range since it was discovered, with only circumstantial evidence of even short distance migrations. It is reportedly locally common within its range, but decidedly restricted to aquatic environments with trees, particularly the banks of large canals and rivers. This dependence on trees by or in water seems consistent, and claims for the species in other habitats need to be reviewed with great care.

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First recorded occurrences in the Yamuna flood plain in 2001

SCS has birdwatched in Haryana for over 25 years. He has focused particularly on the waterways and marshes. On January 3, 2001 he found a male and two female Sind sparrows in a babul tree (*Acacia nilotica*) along the village road between Chitana and Juan villages (15 km north of Sonipat), about 100 m from the Delhi canal. He had never encountered this species before in Haryana. On February 21 and 23, 2001 he found a flock of eight birds (three males and five females), again in babuls, near the village of Rohat, 8 km south of Sonipat, on the banks of the Delhi canal. He saw about the same number,

at the same location, on March 11 and 31, and three birds on April 6 and 22. On April 8, he found a male near Mohamedabad village, 11 km south of Sonipat, on the Delhi canal banks. At the same site, he observed a mating pair in the first week of May and a male on June 3. Thus, three sites within 26 km in Sonipat district held around 15 individuals, from January-June 2001.

In addition, SCS briefly saw one male accompanied by a possible female at the Bhindawas Sanctuary 80 km west-southwest of Delhi on April 22, 2001. This represents a considerable range extension from the Sonipat area. It is probably significant that both the Jawaharlal Nehru Feeder canal, which is connected with Bhindawas Lake via an escape channel, and the Delhi canal originate from the Western Yamuna canal at Sardhana Water Regulator in the Sonipat district. The Sardhana regulator is nearly 25 km north of Sonipat.

Evidence of colonization of the Yamuna flood plain in 2001

On May 13, Bill Harvey (WGH) joined SCS and others to visit his Sonipat sites. At the Mohamedabad site, at least five individuals were seen and a nest located about 3 m high near the trunk of a babul. This nest was still active on May 15, but on May 20 it was deserted. However, its discovery prompted new efforts. After negative results along several kilometres of the Najafgarh drain on May 15, WGH found a singing male at Bhindawas on June 14 and a colony of at least eight active nests, with 11 males and 6 females, on the edge of an incipient water bird colony on an island in the lake, on June 15. On June 28, Nikhil Devasar (a bird watcher from Delhi) and WGH visited the site again to take photographs. They found around 30 birds, half of which were newly fledged juveniles. There were also about ten adult males and five females, some of which were associated with four new nests. The colony probably held a minimum of 10-12 breeding pairs (the active heronry, which occupies two-thirds of the babuls on the island, was not examined to avoid disturbance, so the total could be two or three times that). Thus, in 2001 we obtained evidence for the first time that young Sind sparrows fledged successfully in Haryana.

SCS found the first birds in Delhi region on June 23, with a male and two females in a babul on the Delhi canal bank between Harewali and Jhinjholi villages. At one of the original sites (Juan) he found four nests and associated birds within 100 m of the Delhi canal on June 24. On June 26, 2001, SCS found individuals at two different locations along the JLN Feeder Canal, again on babuls. The latter two locations are at least 30 km northwest of Sonipat and about 15 km apart. One was in Sonipat district and the other was in Rohtak district. New nest sites were found at Tehri on the JLN Feeder Canal (2 nests) on July 3, Kakroi (5 nests) on July 6 and Fatehpur (1 nest) on July 14. On July 29 and August 12, up to 5 birds were found along the Delhi Canal near Garhi Bala. Thus, the species has been recorded in twelve separate places in Haryana State and the Delhi region, with nests located at six of them, and at least 50 individuals, excluding fledged young. This suggests that colonisation is established and records from further sites near the canals and other waterways can be expected. The distribution of these new sites is indicated in Fig. 2.

The current and historical distributions as on August 31, 2001 are indicated in Fig. 1.

Field Descriptions

Although the descriptions of this species available in various field guides are generally accurate, we did observe additional features. No individual variation has been noticed within the sexes. The species is usually initially identified by its subtly different voice, although visual features are striking in males at least, if every sparrow is examined. The species is not, in our

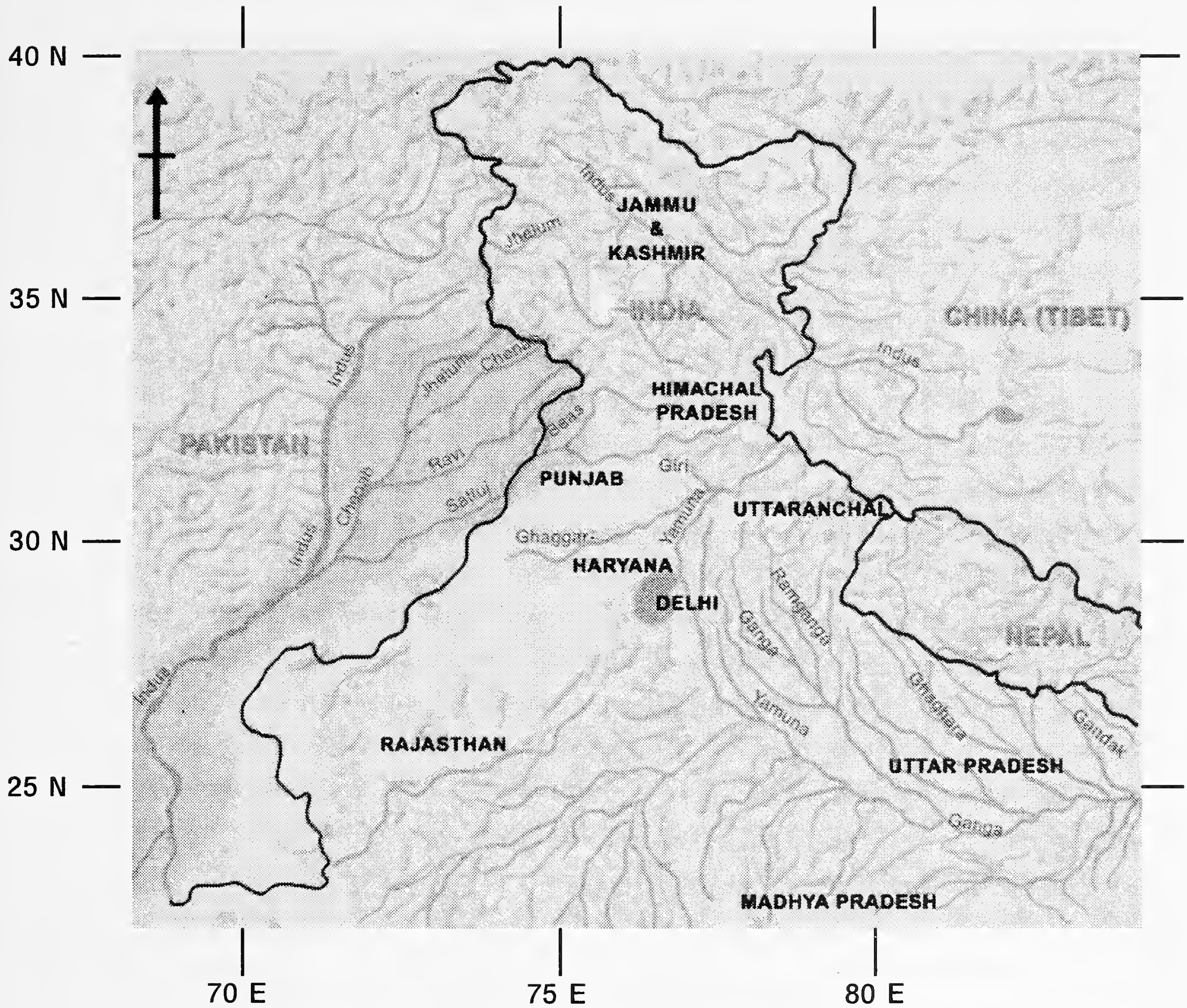

Fig. 1: The world range of the Sind sparrow (light grey) and the area of new colonisation (dark grey)

view, obviously smaller than all house sparrows (often seen with or near Sind sparrows), but it is certainly slimmer, smaller headed and perhaps longer tailed. The bill is neater than that of a house sparrow with a finer, more pointed tip.

The male has a distinctive, quite high-pitched and "rocking" song *chitta chitta chitta*, which is distinct from the chirruping song of house sparrows. Both sexes have a soft *cheep cheep* call, not markedly different from that of house sparrows but quieter. The call and the song are interspersed with a quite distinct, repeated *tswep tswep* call reminiscent of a white wagtail *Motacilla alba*.

The males have a dove-grey forehead, crown and nape; paler grey on the collar and cheeks, contrasting with fairly broad sweeping stripes, from the eyes to half way round the cheeks, which are a distinct bright, russet chestnut, paler and brighter than the similar markings on male house sparrows. The mantle is rich brown with both darker and paler feather edgings, and merging into a distinctly brown back and rump, which in turn merges into narrow, grey upper tail coverts (in contrast to a male house sparrow which has the whole back, rump and upper tail coverts distinctly grey). The lesser coverts are distinctly chestnut and there

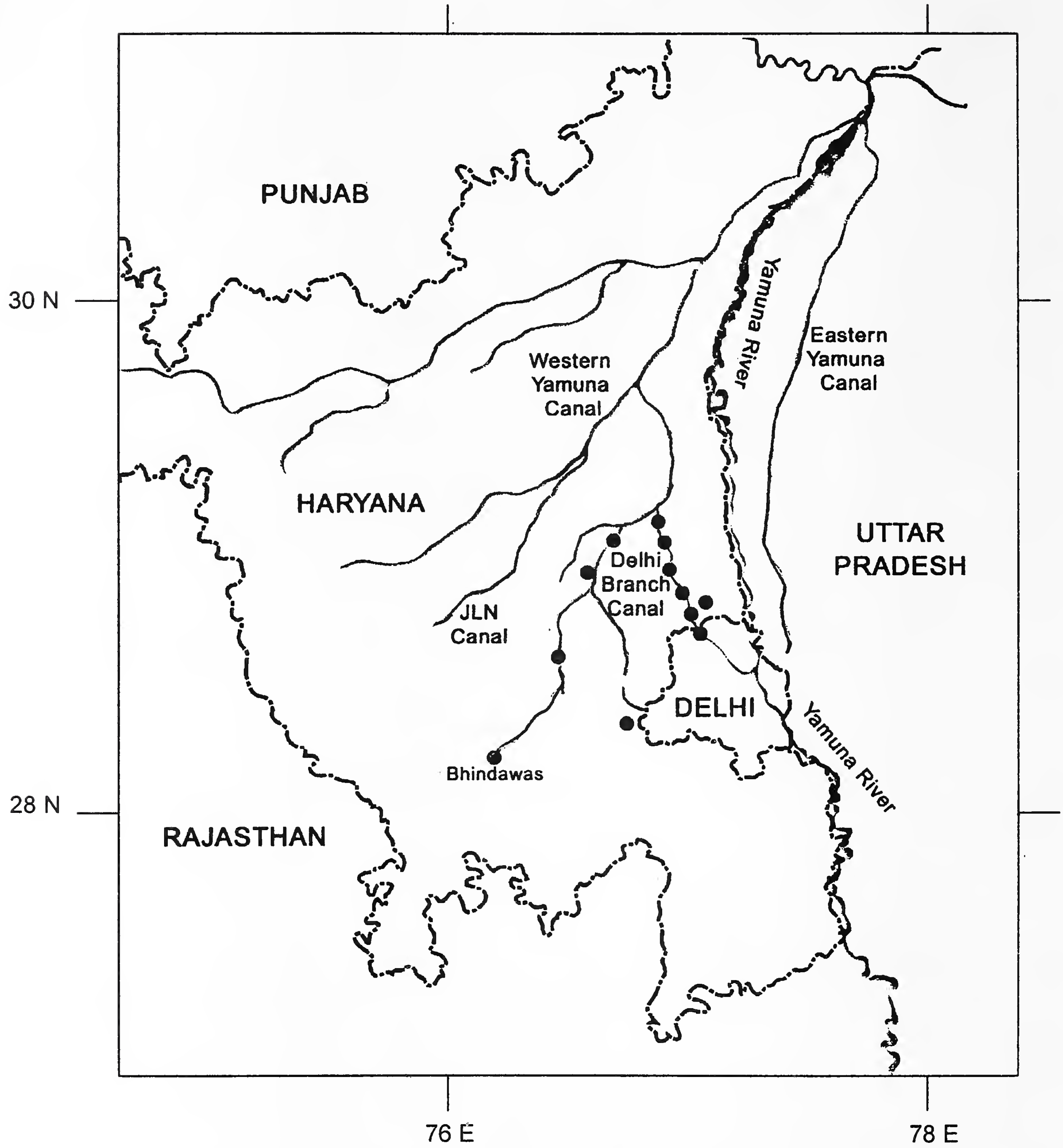

Fig. 2: The Haryana sites (●) of the Sind sparrow showing their proximity to canals and drains

are obvious white tips to the median coverts, adding to the bird's overall bright appearance.

The cheeks are uniform pale grey, merging with limited or no contrast into a grey throat, breast and belly (most published illustrations show a strong contrast between the cheeks and the underparts, but this is not always obvious in the plumages we have been observing). The distinctive black bib is quite long and narrow with straight, clean-edged sides (thus rather

Harvey, Bill *et al.*: Sind sparrow *Passer pyrrhonotus* PLATE 1

NIKHIL DEVASAR

Fig. 1: Male Sind sparrow removing material from old nest to construct new one

NIKHIL DEVASAR

Fig. 2: Female Sind sparrow

rectangular in shape) and quite unlike the round bib (whether small or large and blotched) of male house sparrows of any age. It is not the size of the bib that is important for identification, but the shape. The bills in May-June at least have all been blackish, indicating breeding condition.

The female, although superficially like a female house sparrow, is more distinctive than the field guides suggest (Plate 1, Fig. 2). The broad sweeping pale whitish supercilia run back from the eyes and contrast much more with the plain, pale brown crown and very distinct concolorous grey cheeks. These, unlike in the male, contrast quite markedly with the more house sparrow-like buffish-white throat, breast and belly. The other striking feature is the distinct pale chestnut lesser wing coverts, very similar to those of yellow-throated sparrow *Petronia xanthocollis*. The bill is greyish horn on the upper mandible and yellow on the lower.

The juveniles are similar to the females, but with obvious yellow gapes and fresh plumage. Young males had started developing the male head markings in late June (within two weeks of fledging at most).

Habits

Almost all observations have been of birds calling and/or singing in babul trees. Birds have frequently been observed picking food off babul leaves (or even, perhaps, eating the young leaves) and twice apparently feeding on the ground. A female has been observed feeding on a babul trunk in the manner of a tit (*Parus*). Birds have been seen collecting dry grass from the ground and feathers (from other birds' nests) in the course of nest building, and flying into reed-beds, perhaps with the same purpose. Eucalyptus and other tree species have been used as perches, but the dependence on babuls seems quite marked. There also seems to be a need to be within easy reach of reasonably natural wet grassland and reeds. Groves of babuls on canal banks, with no such marshland vegetation close by (as at Najafgarh) do not seem to be sufficient. As yet, we have only limited observations on their feeding habits and most prolonged observations have been at nest sites.

Nesting

All nests found (25 to date) have been in babul trees. The nest is untidy, oval or semi-oval, made of dry, yellowish grasses (often intermingled with feathers) and lined with finer grasses and feathers. The entrance hole is a quarter way down from the top. It resembles a house sparrow's nest built in the open. Both sexes contribute to the building, although the males spend much time singing and calling while perched close to the nest. In Bhindawas, it was thought that the females were inside incubating or brooding in some cases. All the Sonipat area nests were "free-standing" and close to babul trunks in thick foliage (made so by pruning for fodder). Two nests were in one tree, but the other three were in their own trees.

Nine of the nests at Bhindawas were in the base of other birds' nests. We can find no reference to such breeding sites in the literature, although Summers-Smith (1988) mentions that Jones (1912) recorded them breeding in the old nests of baya weavers *Ploceus philippinus*. The old egret nests at Bhindawas provided the roof and the nest shape was less domed as a result. Seven were in old, probably egret, nests and two were in the base of nests of Asian pied starlings *Sturnus contra*. The starlings may still have occupied one of these nests, as one bird constantly visited and sat on top of the nest, calling. It did not enter the nest, however. This may have been no more than an interest in the new tenants. Two nests were free standing (as in the Sonipat area) and one was built on top of an old (probably egret) nest. A male was observed taking dry grasses from a much reduced used nest, from which young had recently fledged, and contributing

them to a new free-standing nest, presumably for a second brood.

Each nest was in its own babul, 4-5 m above the ground in the canopy. The trees occupied were 10-20 m apart, so that all the calling and singing males were audible to each other. No interactions between different pairs were observed at Bhindawas during the two short visits. However, at the first nest found on May 13 near Mohamedabad, the nesting pair determinedly drove off other Sind sparrows that landed in the nest tree.

Discussion

Circumstantially, the evidence is that the Sind sparrow only colonised parts of Haryana (and Delhi) in 2001, but it has to be admitted that knowledge of the species and coverage of the area has always been extremely limited. It is feasible that colonisation has been progressing for a number of years and it may be that 2001 saw its first consolidation, thus making the species more obvious. But it is still extremely scarce and local everywhere. SCS has been very active in Haryana for many years, and it seems likely that the records from his area (and north Delhi) since January 2001 are genuinely new. In Bhindawas, given the generally inaccessible and inaudible nature of the colony (a wade through nearly 1 m of mud and water is required during the monsoon breeding season, and the birds are usually only audible from the bund at daybreak), it is possible that they have been overlooked by the infrequent birding visitors. SCS visited Bhindawas regularly from 1985-91, so any colonisation is likely to have begun after that date.

Whatever the date of the initiation, and we are certainly talking of the 1990s at the earliest. In a relatively short time, the Sind sparrow, a hitherto largely sedentary and localized species, has crossed a major geographical divide and successfully established a breeding population. The main route into Haryana was probably the Western Yamuna Canal, which divides into the Delhi and Jawaharlal Nehru Feeder Canals at Sardhana. All records to the end of August 2001 have been along or close to these two canals and their link canals. This may have involved crossing no more than a 100 km gap from the upper Sutlej to the Yamuna flood plain, most likely in the region of Ludhiana. Thus, the intricate system of canals, feeders and drains in the Punjab and Haryana has enabled the species to spread because of the eminently sensible practice of planting native babul trees along the bunds to stabilise the soil. Apart from the proximity of water, the major constant in the Sind sparrows' ecological requirements appears to be the babul tree.

Fig. 2 shows the main arteries of the system and the way they connect the established and new sites of the Sind sparrow in India. The species, if it continues to prosper, is on the threshold of the whole Gangetic system. It will be interesting to see if it takes advantage of the great waterways and their tributaries; or whether climatic and other ecological limitations hinder its spread much further. We need to find out much more about the species' diet, social structure, breeding regime and habitat requirements. But it remains a delightful and much underestimated species, well able to co-exist with the house sparrow (its erstwhile, claimed conspecific), and clearly on the move.

Acknowledgement

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EDIBLE OYSTERS OF THE GENUS *CRASSOSTREA* SACCO 1897, ALONG THE RATNAGIRI COAST, MAHARASHTRA, INDIA[1]

M.S. Sawant and A.M. Ranade[2]

Key words: Edible oysters, *Crassostrea gryphoides*, *Crassostrea madrasensis*, *Crassostrea rivularis*, **Ratnagiri coast**

The edible oysters, which provide subsistence level fishery along the Indian coastline, are represented in the Ratnagiri region, Maharashtra State, by three species, namely *Crassostrea gryphoides*, *C. madrasensis* and *C. rivularis*. Based on an extensive series of material, a simple key for their identification is formulated. Information is also given on major synonymy and local distribution. *C. madrasensis* is reported for the first time from the northwest coast of India.

Introduction

Edible oysters are one of the major seafood delicacies along the Indian coastal belt. They also form a subsistence level of fishery, almost throughout the year. Yet, surprisingly little information is available on their species composition, seasonal abundance and ecology, particularly for the Konkan coast of Maharashtra State (west coast of India). Investigation was, therefore, initiated in and around Ratnagiri town, which is one of the major molluscan fishery centres along the Konkan coast. It was revealed that the study area harbours only one oyster genus i.e. *Crassostrea* Sacco, which is described hereunder:

Genus ***Crassostrea*** Sacco

Diagnostic features: Shell valves rather elongate and dissimilar in shape and size; left valve, representing the lower side, attached to the substratum, right valve almost flat, covering the left from above. Hinge without teeth, and ligament partly external. Adductor scar situated dorsolaterally. Sexes separate, but occasional instances of sex reversal and hermaphroditism not uncommon. Oviparous with external fertilization.

Remarks: The known eleven species of Indian edible oysters are all egg laying forms (= oviparous) and included presently under the genus *Crassostrea*: Durve (1967, 1973), Jones (1968), Imai (1971), Rao (1974, 1987). Early workers (Hornell 1910, 1918; Awati and Rao 1931) had erroneously placed them under genus *Ostrea*, which includes only larvae-releasing (= larviparous) forms. Of the 11 species, only 3 were recorded during our investigation, and can easily be distinguished by the following key:

Key to the species of genus *Crassostrea* from the Ratnagiri coast

1. Shell valves more or less uniformly round; left valve rather shallow and attached to substratum with its entire outer surface. Umbonal cavity quite shallow. Adductor muscle scar (oblong) whitish. Almost entire inner surface of shell whitish .... *Crassostrea rivularis* (Gould 1861)

— Shell valves rather irregular in shape; left valve considerably deep, cup-like and attached to substratum by only a small portion towards hinge. Umbo cavity quite deep. Adductor muscle scar (round or kidney shaped) either deep purplish-black or distinctly creamish 2

2. Shell oblong with purplish-black coloration along the margins of the valves. Adductor muscle scar round and distinctly purplish-black .... *Crassostrea madrasensis* (Preston 1916)

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— Shell oval with almost entire inner surface creamish. Adductor muscle scar kidney shaped and distinctly creamish ....
..... *Crassostrea gryphoides* (Schlotheim 1813)

1. ***Crassostrea gryphoides*** (Schlotheim 1813)

Ostracites gryphoides Schlotheim, 1813: 6 (Type locality: Bay of Bengal).

Ostrea gryphoides Vredenburg, 1904: 174; Awati & Rao, 1931: 6.

Crassostrea gryphoides Durve & Bal, 1961: 70; Durve, 1967: 173; Rao, 1974: 27; 1987: 1.

Common English Name: Indian backwater oyster (West coast oyster).

Local, Marathi Name: Kaalav

Material examined: About 500 specimens, size 3.70-16.0 cm, collected from various creeks in and around Ratnagiri, namely Bhatya, Sakhartar, Mirya, Purnagad, Saithawada, Jaitapur from June 1995 to May 1996.

Remarks: *Crassostrea gryphoides* is essentially an euryhaline species inhabiting bays, lagoons, backwaters and creeks. In the open waters, it is found to penetrate up to a depth of 7 m. It is the most common species of oyster in the Ratnagiri region of the district, forming about 77% of the total oyster catch, with extensive beds along the creeks. The shell colour tends to vary with local ecological conditions.

2. ***Crassostrea madrasensis*** (Preston 1916)

Ostrea madrasensis Preston, 1916 (Type locality: Ennur backwater, Madras) Awati and Rao, 1931: 111; Gravely, 1941: 1; Paul, 1942: 1; Satyamurthi, 1956: 68.

Ostrea cucullata Hornell, 1910: 25.

Ostrea virginica Annandale & Kemp, 1916: 329.

Ostrea virginiana Hornell, 1922: 97.

Ostrea virginiana var. *madrasensis* Moses, 1928: 548

Ostrea arakanensis Winckworth, 1931: 188.

Ostrea (*Crassostrea*) *madrasensis* Rao, 1956: 332.

Crassostrea madrasensis Rao, 1958: 55; 1974: 14; 1987: 1; Durve, 1967: 173.

Common English Name: Indian backwater oyster (East coast oyster).

Local, Marathi Name: Kaalav.

Material examined: About 100 specimens, size: 3.7-16.2 cm, collected from Bhatya, Sakhartar and Mirya creeks near Ratnagiri from June 1995 to May 1996.

Remarks: Despite being an euryhaline species like *Crassostrea gryphoides*, *C. madrasensis* exhibits greater penetration into open waters, to a depth of 17 m. So far, it was known only from east and southwest coasts of India (Alagarswami and Narasimham 1973). This is, therefore, the first record of *C. madrasensis* along the northwest coast of India. The species is second in abundance along the Ratnagiri waters, forming about 14% of the total oyster catch. Large to medium size beds of this species are known to occur in Bhatya, Sakhartar and Mirya creeks. Their shell coloration varies according to different localities.

3. ***Crassostrea rivularis*** (Gould 1861)

Ostrea rivularis Gould, 1861: 178 (Type locality: China seas); Cahn, 1950: 12.

Ostrea discoidea Awati & Rao, 1931: 3.

Crassostrea discoidea Rao, 1958: 55; Alagarswami & Narasimham, 1973; 654; Rao, 1974: 36.

Crassostrea rivularis Imai, 1971: 125; Rao, 1987: 1.

Common English Name: Chinese oyster.

Local, Marathi Name: Kaalav.

Material examined: About 60 specimens, size 5.4-11.5 cm, collected from Bhatya and Sakhartar creeks near Ratnagiri from June 1995 to May 1996.

Remarks: *Crassostrea rivularis* appears to be the least common of all local species, forming about 9% of the total oyster yield of the

region. Its beds are located at Bhatya and Sakhartar creeks and in open waters it has restricted distribution, to a depth of 7 m only.

Conclusion: From the foregoing account, it appears that the Indian west coast backwater oyster *Crassostrea gryphoides* is the most common species inhabiting the Ratnagiri waters, followed by *C. madrasensis* and *C. rivularis* in order of abundance. This is also the first record of the Indian east coast backwater oyster *C. madrasensis* along the northwest coast of India.

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FRESHWATER FISHES OF SOUTHERN KERALA WITH NOTES ON THE DISTRIBUTION OF ENDEMIC AND ENDANGERED SPECIES[1]

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Key words: Freshwater fishes, southern Kerala, distribution, endemic, endangered

Freshwater fishes were collected from rivers of southern Kerala from November 1996 to April 2000. A total of 117 species belonging to 58 genera, 27 families, and 10 orders were recorded. The most abundant order was Cypriniformes, followed by Perciformes and Siluriformes. The distribution of 36 endangered and 11 endemic species is also included. Most of the endangered fish are restricted to one or two rivers.

Introduction

The Western Ghats are one of the selected biodiversity hotspots in the world. According to the distribution of hill-stream fishes, Bhimachar (1945) has divided the Western Ghats into three major regions. These geographic regions are northern division (Surat to Goa), central division (Goa to Nilgiri mountains) and southern division (south of Palghat Gap). The Western Ghats form the major watershed in Kerala and 44 rivers originate from it. Of these, 19 rivers and a portion of Bharathapuzha river flow through the southern part of Kerala. The freshwater fishes collected from these rivers and the distribution of endemic and endangered species are given in this paper.

The first monumental work on FISHES OF MALABAR was by Francis Day (1865). The next ichthyofaunal study in southern Kerala was by Pillay (1929) followed by John (1936). Hora and Law (1941) published a comprehensive list of freshwater fishes from Travancore. Other intensive freshwater fish fauna studies were conducted in southern Kerala by Raj (1941), Herre (1942), Silas (1950, 1951, 1954, 1958), Menon (1950, 1951), Rita *et al.* (1978), Rema Devi and Indra (1984), Rema Devi and Menon (1992), Pethiyagoda and Kottelat (1994), Menon and Rema Devi (1995), Menon and Jacob (1996), Easa and Shaji (1996), Zacharias *et al.* (1996), Biju *et al.* (1999), Ajith Kumar *et al.* (1999) and Raju Thomas *et al.* (1999, 2000a, b).

Though there are a number of publications on freshwater fish fauna from southern Kerala, studies on fish assemblages have been carried out only in a few river segments. We provide an updated assessment of the conditions and status of the freshwater fishes in southern Kerala, with special reference to species regarded as endemic and endangered.

Study Area

Kerala is situated in the southwest corner of India (8° 17' 30"-12° 47' 40" N and 74° 51' 57"-77° 24' 47" E). The Western Ghats, as a natural wall on the eastern side, and the Arabian Sea on the western side, flank the State. The Western Ghats protect the State from the dry winds of the eastern plateau and provide steady rainfall during the monsoon.This range has only one major discontinuity — the Palghat Gap in Kerala, dividing the state into two parts: north and south of Palghat Gap. We selected the southern part as our study area. Natural topographic features such as mountain ridges and valleys divide southern Kerala into a number of divisions: Agasthyamalai Range, Pandalam

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Hills, Cardamom Hills, The High Ranges, and the Nelliampathy and Anaimalai Hills (Nair 1991). The land resources of these areas generally fall into four well defined natural divisions: 1) Lowland (< 75 m above msl), 2) Midland (75 to 500 m above msl), 3) Highland (500 to 750 m above msl), and 4) High Ranges (> 750 m above msl).

The highest peak in the Western Ghats, the Anamudi (2,690 m above msl) is situated in the study area. Most of the reserve forests and sanctuaries of the study area are in the Highland region. Eravikulam is the only national park in this area. The study area includes the following sanctuaries: Neyyar, Chendurni, Peppara, Periyar, Idukki, Thattekkad, Chimmony, Parambikulam, and Peechi-Vazhani. In the present study, fishes were collected from 19 rivers and also from a portion of the Bharathapuzha river. Specimens were collected from all the rivers except Peppara Sanctuary area of Karamana river, Chendurni Sanctuary of Kallada river, and Periyar Sanctuary area of Periyar river.

Methods

A survey was carried out during November 1996 to April 2000 in the rivers flowing through southern Kerala. Studies were mainly done in the post-monsoon periods. However, some collections were made during pre-monsoon and monsoon periods. 1: 50,000 topographical maps of the Survey of India were used to trace the river system and pinpoint the collection sites. Samples were collected from several approachable areas of each stream of the main river. As our study period was post-monsoon, the water was rarely turbid. Fish samples were collected by using cast net, scoop net, gill net, and a circular net with very small mesh size and sinkers on the edge. Constant efforts were made to reduce statistical bias. Samples were preserved in 10% formaline and kept in the field station for identification and further studies. The works of Jayaram (1981, 1999), Datta Munshi and Srivastava (1988), Talwar and Jhingran (1991), and Menon (1998) were followed for the identification of fishes.

According to the IUCN criteria, the fishes of Kerala can be grouped into two categories: Threatened and Non-threatened. The category Threatened is further divided into (1) Critically Endangered (CR), (2) Endangered (EN), and (3) Vulnerable (VU). The Non-threatened category is divided into (1) Low Risk-nearly threatened (LR-nt) and (2) Low Risk- of least concern (LR-lc). These criteria are more applicable to a single river. Since we had covered 20 rivers, we adopted the IUCN criteria with some modifications. In our analysis, we classified the species based on restricted distribution of the species, area of occupancy of the species, and the number of species recorded. The criteria adopted are as follows:

Critically Endangered: (a) species with distribution restricted to a single river, (b) area of occupancy limited to a single location in that river, and (c) the number of species estimated to be less than five in the collection site.

Endangered: (a) species with distribution restricted to 1-3 rivers, (b) area of occupancy of less than 5 collection sites in the rivers from where they are recorded, and (c) the number of species estimated to be less than 10 in the collection sites.

Vulnerable: (a) species with distribution restricted to 4-8 rivers, (b) area of occupancy of less than 10 collection sites in the rivers from where they were collected, and (c) the number of species estimated to be less than 10 in the collection sites.

Low Risk-nearly threatened: (a) species with wide distribution in 8-15 rivers, (b) area of occupancy of more than 20 collection sites in the rivers from where they were recorded, and (c) the number of species estimated to be less than 15 in the collection sites.

Low Risk-least concern: (a) species with wide distribution in more than 15 rivers, (b) area of occupancy of more than 20 collection sites in the rivers from where they were recorded, and (c) the number of species estimated to be more than 15 in the collection sites.

Results and Discussion

A total of 117 species of freshwater fishes, belonging to 58 genera of 27 families and 10 orders were recorded from the rivers flowing through southern Kerala (Table 1). The most abundant order was Cypriniformes, followed by Perciformes and Siluriformes. The family with the maximum number of representatives was Cyprinidae. The most abundant genus was *Puntius* followed by *Mystus* and *Nemacheilus*.

The list of Critically Endangered and Endangered species is given in Table 2. Under these categories, 26 species were recorded from a single river alone. All these species are considered threatened, as their distribution is restricted and there is an alarming decrease in their numbers. The following are considered as endemic species: *Puntius denisonii* (Day), *Osteobrama bakeri* Day, *Garra surendranathanii* Shaji *et al*, *Osteochilus longidorsalis* Pethiyagoda and Kottelat, *Chela fasciata* Silas, *Travancoria jonesi* Hora, *Nemacheilus pambarensis* Rema Devi and Indra, *N. keralensis* Rita and Nalbant, *Horabagrus brachysoma* (Günther), *H. nigricollaris* Pethiyagoda and Kottelat, and *Batasio travancoria* Hora and Law. Distribution of most of these species is given in Table 2. *Puntius denisonii* inhabit Bharathapuzha, Chalakudy, Periyar, Pamba and Achankovil rivers, *Osteobrama bakeri* inhabit Bharathapuzha, Karuvannur, Chalakudy, Periyar, Muvattupuzha, Meenachil, Achankovil and Manimala rivers, while *Horabagrus brachysoma* is distributed in almost all the river systems of southern Kerala.

Table 1
SYSTEMATIC LIST, ABUNDANCE AND STATUS OF FRESHWATER FISHES COLLECTED FROM SOUTHERN KERALA

No.	Name of Species	Abundance	Status
	ORDER I: Osteoglossiformes		
	1. **Family**: Notopteridae		
1	*Notopterus notopterus* (Pallas)	+	VU
	ORDER II: Anguilliformes		
	2. **Family**: Anguillidae		
2	*Anguilla bengalensis* (Gray)	+++	LR-nt
3	*A. bicolor bicolor* McClelland	+	VU
	3. **Family**: Ophichthidae		
*4	*Pisodonophis boro* (Ham.)	+	EN
	ORDER III: Clupeiformes		
	4. **Family**: Clupeidae		
5	*Dayella malabarica* (Day)	+++	LR-lc
	ORDER IV: Cypriniformes		
	5. **Family**: Cyprinidae		
6	*Catla catla* (Ham.)	++	INTR
7	*Cirrhinus mrigala* (Ham.)	++	INTR
8	*Ctenopharyngodon idellus* (Val.)	++	INTR
9	*Cyprinus carpio communis* L.	+++	INTR
10	*Hypselobarbus curmuca* (Ham.)	++	VU
11	*H. kolus* (Sykes)	++	VU
12	*H. kurali* Menon and Rema Devi	+++	VU
*13	*H. thomassi* (Day)	+	EN
14	*Labeo calbasu* (Ham.)	+	VU
15	*L. rohita* (Ham.)	+++	INTR
16	*Osteobrama bakeri* Day	++	VU
*17	*O. cotio peninsularis* Silas	+	EN
*18	*Osteochilus longidorsalis* Pethiyagoda and Kottelat	+	EN
*19	*O. nashii* (Day)	+	EN
*20	*O. thomassi* (Day)	+	EN
21	*Barbodes carnaticus* (Jerdon)	++	VU
22	*B. sarana subnasutus* (Val.)	+++	LR-lc
23	*Puntius amphibius* (Val.)	++++	LR-lc
24	*P. arulius* (Jerdon)	+++	VU
25	*P. chola* (Ham.)	+++	LR-lc
26	*P. conchonius* (Ham.)	++	LR-nt
27	*P. denisonii* (Day)	+	VU
28	*P. dorsalis* (Jerdon)	++	VU
29	*P. filamentosus* (Val.)	++++	LR-lc
30	*P. jerdoni* (Day)	++	VU
31	*P. melanampyx* (Day)	+++	LR-lc

TABLE I (CONTD.)
SYSTEMATIC LIST, ABUNDANCE AND STATUS OF FRESHWATER FISHES COLLECTED FROM SOUTHERN KERALA

No.	Name of Species	Abundance	Status
*32	*P. melanostigma* (Day)	+	EN
*33	*P. ophicephalus* Raj	+	CR
34	*P. parrah* Day	++	LR-nt
35	*P. sophore* (Ham.)	++	LR-nt
36	*P. ticto* (Ham.)	++++	LR-lc
37	*P. vittatus* Day	++++	LR-lc
38	*Tor khudree* (Sykes)	++	VU
*39	*Chela fasciata* Silas	+	EN
40	*Salmostoma acinaces* (Val.)	++	VU
41	*S. boopis* (Day)	+++	LR-nt
*42	*S. clupeiodes* Bloch	+	EN
43	*Amblypharyngodon melettinus* (Val.)	++++	LR-lc
44	*Barilius bakeri* Day	+++	LR-nt
45	*B. bendelisis* (Ham.)	++	VU
*46	*B. canarensis* (Jerdon)	+	EN
47	*B. gatensis* (Val.)	+++	LR-nt
48	*Danio aequipinnatus* (McClelland)	++++	LR-lc
49	*D. malabaricus* (Jerdon)	++++	LR-lc
50	*Parluciosoma daniconius* (Ham.)	++++	LR-lc
51	*Esomus danricus* (Ham.)	++	VU
*52	*E. thermoicos* (Val.)	+	EN
*53	*Garra mcclellandi* (Jerdon)	++	EN
*54	*G. menoni* Rema Devi and Indra	++	EN
55	*G. mullya* (Sykes)	++++	LR-lc
*56	*G. hughi* Silas	+	EN
57	*G. gotyla stenorhynchus* (Jerdon)	++	VU
*58	*G. surendranathanii* Shaji *et al.*	++	EN
*59	*Horalabiosa joshuai* Silas	+	CR
	6. **Family**: Balitoridae		
60	*Bhavania australis* (Jerdon)	++	VU
*61	*Balitora mysorensis* Hora	+	CR
*62	*Travancoria jonesi* Hora	+	EN
63	*Nemacheilus denisoni denisoni* Day	++	VU
*64	*N. pambarensis* Rema Devi and Indra	+	EN
*65	*N. evezardi* Day	+	EN
66	*N. guentheri* Day	+++	LR-nt
*67	*N. keralensis* (Rita *et al.*)	++	EN
*68	*N. monilis* Hora	+	CR
*69	*N. semiarmatus* Day	++	EN
70	*N. triangularis* Day	+++	LR-lc
	7. **Family**: Cobitidae		
*71	*Pangio goaensis* (Tilak)	+	EN
72	*Lepidocephalus thermalis* (Val.)	++++	LR-lc
	ORDER V: Siluriformes		
	8. **Family**: Bagridae		
73	*Horabagrus brachysoma* (Günther)	++	VU
*74	*H. nigricollaris* Pethiyagoda and Kottelat	+	CR
*75	*Batasio travancoria* Hora and Law	++	EN
76	*Mystus armatus* Day	+++	LR-nt
*77	*M. bleekeri* (Day)	+	EN
78	*M. cavasius* (Ham.)	++	LR-nt
79	*M. gulio* (Ham.)	+++	LR-lc
80	*M. malabaricus* (Jerdon)	++	VU
*81	*M. montanus* (Jerdon)	+	EN
82	*M. oculatus* (Val.)	++++	LR-lc
*83	*M. punctatus* (Jerdon)	+	EN
*84	*M. vittatus* (Bloch)	+	EN
	9. **Family**: Claridae		
85	*Clarias dussumieri* (Val.)	++	VU
	10. **Family**: Claridae		
86	*Heteropneustes fossilis* (Bloch)	++	VU
	11. **Family**: Siluridae		
87	*Ompok bimaculatus* (Bloch)	+++	LR-nt
*88	*O. malabaricus* (Val.)	++	EN
89	*Wallago attu* (Schneider)	+++	LR-nt
	12. **Family**: Schilbeidae		
*90	*Pseudeutropius mitchelli* Günther	+	EN
	13. **Family**: Sisoridae		
*91	*Glyptothorax annandalei* Hora	+	EN
92	*G. madraspatanus* (Day)	++	VU
*93	*G. lonah* (Sykes)	+	EN
	ORDER VI: Salmoniformes		
	14. **Family**: Salmonidae		
94	*Salmo gairdnerii irredius* Richardson	+	INTR
	ORDER VII: Cyprinodontiformes		
	15. **Family**: Belonidae		
95	*Xenentodon cancila* (Ham.)	++++	LR-lc
	16. **Family**: Aplocheilidae		
96	*Aplocheilus lineatus* (Val.)	++++	LR-lc
	17. **Family**: Poecilidae		
97	*Lebistes reticulata* Peters	++	INTR
	ORDER VIII: Syngnathiformes		
	18. **Family**: Syngnathidae		
98	*Microphis cuncalus* (Ham.)	+++	LR-lc

TABLE 1 (CONTD.)
SYSTEMATIC LIST, ABUNDANCE AND STATUS OF FRESHWATER FISHES COLLECTED FROM SOUTHERN KERALA

No.	Name of Species	Abundance	Status
	ORDER IX: Perciformes		
	19. **Family**: Ambassidae		
99	*Chanda nama* (Ham.)	++	LR-nt
100	*Parambassis dayi* (Bleeker)	++++	LR-lc
101	*P. thomassi* (Day)	++	LR-nt
	20. **Family**: Nandidae		
102	*Nandus nandus* (Ham.)	+++	LR-lc
103	*Pristolepis marginata* Jerdon	++	VU
	21. **Family**: Cichlidae		
104	*Etroplus maculatus* (Bloch)	++++	LR-lc
105	*E. suratensis* (Bloch)	+++	LR-lc
106	*Oreochromis mossambica* (Peters)	++++	INTR
	22. **Family**: Gobiidae		
107	*Glossogobius giuris* (Ham.)	++++	LR-lc
*108	*Sicyopterus griseus* (Day)	+	EN
	23. **Family**: Anabantidae		
109	*Anabas testudineus* (Bloch)	+++	LR-lc
	24. **Family**: Belontidae		
110	*Macropodus cupanus* (Val.)	+++	LR-lc
	25. **Family**: Channidae		
111	*Channa marulius* (Ham.)	+++	VU
112	*C. orientalis* Bloch and Schneider	++	VU
113	*C. punctatus* (Bloch)	++	VU
114	*C. striatus* (Bloch)	+++	VU
	26. **Family**: Mastacembelidae		
115	*Mastacembelus armatus* (Lacepede)	+++	LR-nt
116	*Macrognathus guentheri* (Day)	+++	LR-nt
	ORDER X: Tetraodontiformes		
	27. **Family**: Tetraodontidae		
117	*Tetraodon travancoricus* Hora and Nair	+++	VU

CR - Critically Endangered; EN - Endangered; VU - Vulnerable; LR-nt - Low Risk-nearly threatened; LR-lc - Low Risk-least concern; INTR - Introduced; + = Very rare; ++ = Rare; +++ = Common; ++++ = Very common; * = Critically endangered / Endangered species

TABLE 2
LIST OF CRITICALLY ENDANGERED AND ENDANGERED FISHES AND THEIR DISTRIBUTION IN SOUTHERN KERALA

No.	Name of Species	Distribution
1	*Pisodonophis boro* (Ham.)	Periyar and Achankovil rivers
2	*Hypselobarbus thomassi* (Day)	Periyar river
3	*Osteobrama cotio peninsularis* Silas	Periyar river
4	*Osteochilus longidorsalis* Pethiyagoda and Kottelat	Chalakudy river
5	*O. nashii* (Day)	Periyar river
6	*O. thomasii* (Day)	Periyar river
7	*Puntius melanostigma* (Day)	Achankovil river
8	*P. ophicephalus* Raj	Periyar river
9	*Chela fasciata* Silas	Bharathapuzha river
10	*Salmostoma clupeoides* (Bloch)	Chalakudy and Periyar rivers
11	*Barilius canarensis* (Jerdon)	Bharathapuzha and Manimala rivers
12	*Esomus thermoicos* (Val.)	Bharathapuzha river
13	*Garra mcclellandi* (Jerdon)	Chalakudy, Bharathapuzha and Periyar rivers
14	*G. menoni* Rema Devi & Indra	Pambar river
15	*G. hughi* Silas	Pambar river
16	*G. surendranathanii* Shaji *et al.*	Chalakudy, Periyar and Pamba rivers
17	*Horalabiosa joshuai* Silas	Pambar river
18	*Balitora mysorensis* Hora	Bharathapuzha river
19	*Travancoria jonesi* Hora	Chalakudy and Periyar rivers
20	*Nemacheilus pambarensis* Rema Devi and Indra	Pambar river
21	*N. evezardi* (Day)	Pambar river
22	*N. keralensis* Rita *et al.*	Periyar and Muvattupuzha rivers
23	*N. monilis* Hora	Pambar river

TABLE 2 (CONTD.)
LIST OF CRITICALLY ENDANGERED AND ENDANGERED FISHES AND THEIR DISTRIBUTION IN SOUTHERN KERALA

No.	Name of Species	Distribution
24	*N. semiarmatus* (Day)	Pambar river
25	*Pangio goaensis* (Tilak)	Manimala river
26	*Horabagrus nigricollaris* Pethiyagoda and Kottelat	Chalakudy river
27	*Batasio travancoria* Hora and Law	Pamba, Manimala, and Periyar rivers
28	*Mystus bleekeri* (Day)	Neyyar river
29	*M. montanus* (Jerdon)	Periyar river
30	*M. punctatus* (Jerdon)	Karuvannur river
31	*M. vittatus* (Bloch)	Periyar river
32	*Ompok malabaricus* (Val.)	Chalakudy and Karuvannur rivers
33	*Pseudeutropius mitchelli* Günther	Periyar river
34	*Glypotothorax annandalei* (Hora)	Muvattupuzha river
35	*G. lonah* (Sykes)	Chalakudy river
36	*Sicyopterus griseus* (Day)	Chalakudy and Periyar rivers

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CHARACTERISTICS AND SIGNIFICANCE OF SONG IN FEMALE ORIENTAL MAGPIE-ROBIN, *COPSYCHUS SAULARIS*[1]

ANIL KUMAR[2,3] AND DINESH BHATT[2]

(*With one text-figure*)

Key words: *Copsychus saularis*, song of female, communication, territorial defence, spectrograms

Singing behaviour of the female Oriental magpie-robin, *Copsychus saularis* was studied. The female sings occasionally for a short period in the presence of the male. The song consists of phrases made up of different elements. The minimum, maximum and range of frequencies were found to be 2.42 ±0.03, 5.03 ±0.08 and 2.61 ±0.02 kHz, respectively while the duration of the phrases were 1.38 ±0.02 sec, followed by an interval of 1.49 ±0.03 sec. It appears that the female magpie-robin's song helps to stimulate the male to sing.

INTRODUCTION

Bird song performs a variety of functions (Ali 1996). In most passerine species, song is the characteristic of the male and is used for territorial defence through advertisement and mate acquisition (Cooney and Cockburn 1995, Bhatt *et al.* 2000). Besides these two functions, birds also use the song to synchronize breeding behaviour, mate guarding, mate recognition, parent-offspring recognition and neighbour-stranger discrimination (Weary *et al.* 1992, Lambrechts and Dhondt 1995). The song in the female has also been studied in many passerine species. In some species it is rare, while in others the females normally sing duets with males (Ridgely and Tudor 1989). The major functions of the song of the female include territorial defence, prevention of polygyny and intra-pair communication (Flood 1990).

In the present study, an attempt has been made to investigate physical characteristics and functional significance of the song in the female Oriental magpie-robin, *Copsychus saularis*.

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METHODOLOGY

The Oriental magpie-robin breeds during March to August in northern India (Ali 1996, Roberts 1992, Kumar 1999). Songs of five females were recorded from March 1997 to August 1998, at Haridwar (29° 55' N, 78° 8' E), using a JVC Zoom MZ-500 unidirectional microphone and a SONY CFS 1030S tape recorder. Most signals were recorded at a distance of 2-5 m. Pre- and post-signalling behaviour and circumstances in which signalling occur were observed to infer the meaning of the song. After editing, cuts of high quality recordings (a few seconds duration) were used for physical analysis (characteristics based on frequency and duration). In the present study, we used minimum frequency, maximum frequency, range of frequencies, duration of phrases and interval between phrases, to define the physical characteristics of the songs. The analysis was made with the help of Scientific 25 MHz Digital Storage Oscilloscope HM205-3, interfaced with a PC (Pentium) and signal analyzer software SP 91 (Bhatt *et al.* 2000). Spectrograms were generated with the help of DSP Sonagraph™ 5500 machine using SIGNAL™, a software package for sound generation and analysis.

Results

The female Oriental magpie-robin occasionally sings a short, low amplitude song in the presence of the male. In most cases (n=7), they were observed singing alone. However, male and female were once seen singing a duet at a distance of about 25 cm. The female song consists of phrases, either similar (repetition of same phrase) or dissimilar in structure as observed in male birds. Minimum, maximum and range of frequencies were found to be 2.42 ±0.03, 5.03 ±0.08 and 2.61 ±0.02 kHz respectively, while the duration of phrases was 1.38 ±0.02 sec followed by an 1.49±0.03 sec interval (Fig. 1). Since the female sings rarely, only a few song samples could be recorded and the analysis is restricted to a few select phrases. Analysis of the data reveals that the female uses almost the same frequency pattern as the male birds do (Table 1). Interestingly, the female started singing before the male. Thus, it appears that in *C. saularis*, onset of breeding is indicated by female song. However, in some males (n=4), the singing was initiated on listening to the song of neighbouring males. In two cases, the female was found singing at the time of the second brood, just before the mating. It appears that the function of the female song in magpie-robin is to stimulate the male for (i) initiation of breeding activities (i.e. formation of breeding territory), and (ii) courtship.

Discussion

Our results reveal that the female *Copsychus saularis* sings rarely, and uses almost same frequencies as male birds. However, the maximum frequency, range of frequencies and relative amplitude was found to be higher in males (Table 1). The female rarely sings. It seems that the biological significance of the female's song is restricted to initiating the males to sing, while in males the song is common during breeding and is used for territorial defence and mate acquisition (Bhatt *et al.* 2000).

In many species of birds and mammals, both the sexes live together throughout the year but courtship takes place when a female gives signs of readiness in the form of olfactory/vocal/ visual cue(s). In the magpie-robin group, females normally use singing for this purpose. In the polygynous redwinged blackbird, *Agelaius phoeniceus* of North America, Beletsky (1983)

Table 1

COMPARATIVE ACCOUNT OF THE PHYSICAL AND ASSOCIATED CHARACTERISTICS OF SONG OF MALE AND FEMALE, ORIENTAL MAGPIE-ROBIN *COPSYCHUS SAULARIS*

S. No.	Characteristics	Female	Male (Bhatt *et al.* 2000)
1.	Number of individuals (N), studied	5	14
2.	Number of samples (n), taken for statistical analysis (mean ±SE)	12	84
3.	Minimum frequency (kHz)	2.42 ±0.03	2.39 ±0.04
4.	Maximum frequency (kHz)	5.03 ±0.08	5.41 ±0.07
5.	Range of frequency (kHz)	2.61 ±0.02	3.19 ±0.11
6.	Duration of phrases (sec)	1.38 ±0.02	1.52 ±0.05
7.	Interval between phrases (sec)	1.49 ±0.03	1.09 ±0.04
8.	Relative amplitude	Low	High
9.	Use of song	Rare	Common in breeding season
10.	Conspecific context	Always observed in the presence of male	Irrespective of the presence / absence of female
11.	Biological function	Probably initiate the males to sing	For territory advertisement and mate acquisition

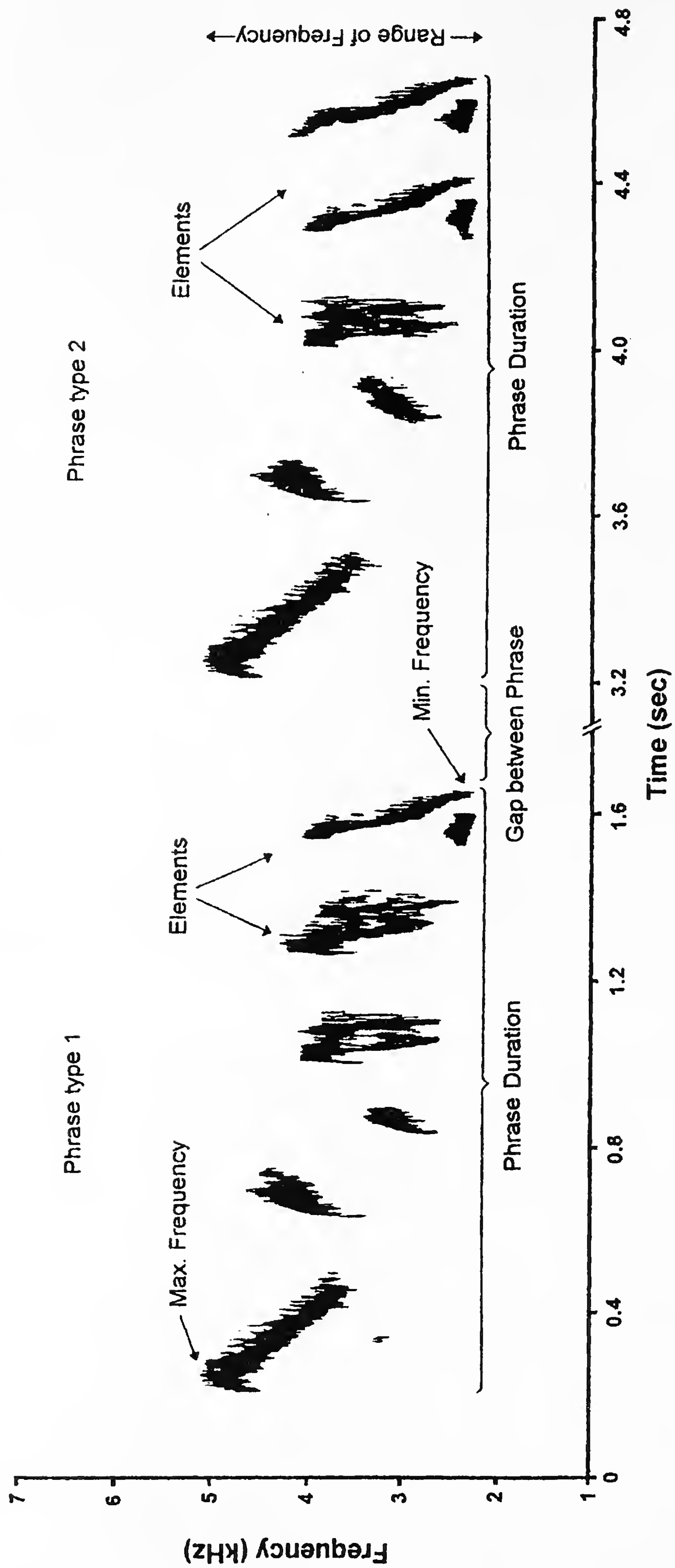

Fig. 1: Spectrogram of the song of the female Oriental magpie-robin *Copsychus saularis* showing the different physical characteristics, namely maximum frequency, minimum frequency, range of frequency, duration of phrases and interval between phrases.

found two types of female song with varied functions. These songs probably help in communication between the mated pair and are aggressive signals. As in the Oriental magpie-robin, the song of the female European robin, *Erithacus rubecula* is shorter and simpler than the male song (Lack 1946). Female white-crowned sparrow, *Zonotrichia leucophrys* also produce a song, which is structurally similar to that of the male, but usually shorter in duration (Baptista *et al.* 1993).

In the European robin, *Erithacus rubecula* the female song is clearly related to the winter territorial behaviour (Hoelzel 1986), while in Oriental magpie-robin the female generally does not exhibit territorial behaviour. However, during breeding if a predator appears in the territory, the female helps the male to chase it away, both producing threat calls. The female was never observed chasing conspecifics during this study. In Northern cardinals, *Richmondena cardinalis*, Ritchison (1986) found that females sang during a particular phase of the breeding cycle, just before nesting, and there was no evidence from field observations or playback experiments that female song helped to establish or defend territory, just as in the Oriental magpie-robin. The song of the Northern cardinal seemed to stimulate the males to join in and sing as well. It is suggested that female song in cardinals might function in pair bonding or synchronising reproductive physiology (Ritchison 1986, Moller 1991).

The present study indicates that the magpie-robin is a good model to study the functional significance of song of female birds. It provides basic information on the song of the female magpie-robin. A detailed study is required to know the repertoire of female song and its functional significance.

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PSYCHOPHILY AND EVOLUTIONARY CONSIDERATIONS OF *CADABA FRUTICOSA* L. (CAPPARACEAE)[1]

J.S.R. Aluri and S.P. Rao[2]

Key words: *Cadaba fruticosa*, androgynophore, nectarial tube, *Colotis eucharis*, *C. danae*, psychophily, co-evolution

Cadaba fruticosa is a perennial shrub, which flowers almost round the year. Floral characters, such as the opening of the flower during early hours of the day, green colour of the flower, a nectarial tube with good amount of nectar, and this tube along with the androgynophore and petals serving as landing place for the probing flower visitors, conform to psychophily.

C. fruticosa breeds through geitonogamy and xenogamy only, and the pollination is effected exclusively by pierid butterflies, namely *Colotis eucharis*, *C. danae* and *Anaphaeis aurota*. This study concludes that *Cadaba* and *Colotis* have co-evolved and any disturbance in the habitat is bound to affect both.

Introduction

Certain plant species possess highly specialized floral forms and structures associated with particular species of insect pollinators. Specialization nearly always tends towards enabling the plant to adapt to a limited range of pollinating insects. The specialized forms of plants develop through morphological adaptations over a period of time.

The specialized floral forms adapted to butterfly-pollination have been scantily reported in literature (Cruden and Hermann-Parker 1979, Dronamraju 1960, Dronamraju and Spurway 1960, Hawkswood 1985, Ilse and Vaidya 1956, Jennerston 1984, Khare 1975, Levin 1972, Reddi and Meerabai 1984). These workers showed that the butterflies could serve as efficient pollinators, because the floral forms are specialized for foraging exclusively by them.

In the present study, it was found that an adaptive relationship existed between the flowers of *Cadaba fruticosa* and the pierid butterflies i.e. both partners exhibit interdependency. Structural and functional aspects of *C. fruticosa* flower and the foraging details of pierid butterflies are presented and discussed from the perspective of psychophily and co-evolution.

Material and Methods

Cadaba fruticosa plants growing wild near the Indira Gandhi Zoological Park at Visakhapatnam (17° 42' N and 82° 18' E) were observed periodically. The phenology of their flowering was recorded. To study the flower production and life of an inflorescence, the opening of flowers of 20 marked inflorescences were recorded every day. Floral events, such as flower opening and anther dehiscence were recorded through continuous observation. The nectar, accumulated in flowers covered with butter paper bags, was quantified using graduated micropipettes. Its sugar concentration and composition were determined by a refractometer and paper chromatography respectively. Presence of proteins and amino acids was determined by spot tests as per Baker and Baker (1973) Method. Number of pollen grains per anther, pollen viability, stigma receptivity and mode of reproduction, natural fruit set, seed set and fecundity were determined as per Aluri and Reddi (1994) and Aluri *et al.* (1998). BUTTERFLIES OF THE INDIAN REGION (Wynter-Blyth 1957) was used

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to identify butterflies captured at flowers of *C. fruticosa*. The number of foraging visits made in a single foraging bout was recorded for each butterfly species, and number of visits per minute were counted using a stopwatch. The relative frequency of visits of different butterfly species was determined through censuses on different days at different plants. The behaviour of butterflies at the flowers was also noted carefully. The floral characters and foraging behaviour of butterflies were thoroughly examined for their adaptive relationship.

Results

Flowering Phenology: It is a perennial shrub which flowers almost round the year. Flowering of different conspecific individuals is largely synchronous during the rainy season from June to September, and asynchronous during the rest of the year. Intense flowering occurs during the rainy season. The inflorescence is a fascicle with solitary and axillary flowers, and bears an average of 9 flowers that mature over 14-30 ($\bar{x}$ = 22) days. The mature flower buds that arise from the axial point do not all mature on the same day.

Flower Morphology: Flowers pedicellate, oriented horizontally. Thalamus elongated into a slender structure on which floral parts occur at different levels. Androphore is a part of the thalamus between the perianth and the stamens, whereas gynophore is present between the stamens and the gynaecium. The entire structure is known as an androgynophore. Additionally, there is a nectar-secreting tubular structure separated from the base of the androgynophore. Four free sepals arranged in two whorls of two each (two median sepals in the outer whorl and two inner sepals transverse). Four free, clawed petals arranged in one whorl alternate with the four stamens. Gynaecium raised up on a prominent gynophore, bicarpellary, syncarpous, unilocular, with an average of 11 ovules arranged on the parietal placentation.

Floral Events: Flowers begin to open slowly from 0130 hrs and proceed to unfold the sexual organs in about 2½ hours. The flowers with exposed sex organs are available from 0345 hrs onwards on sunny days and an hour later on cloudy and rainy days. Anther dehiscence occurs after sunrise at 0730 hrs in flowers under sunshine, and an hour later in flowers which are in shade. The pollen grains are spheroidal with psilate exine, separable into two size classes, 28 µm and 19.4 µm. Their number per anther ranged from 7,870-8,240 ($\bar{x}$ = 8,080). *In vivo* tests showed that the pollen grains remain viable for 27 hours after anther dehiscence; the grains stored for 15 hours have 80% fruit set. Pollen-ovule ratio is 3000:1. In the early flower-life, the style and stigma are curving while the dehisced anthers stand erect. Gradually, the stigma uncurves, stands erect and attains equal height with the stamens at 1100 hrs and remains so till the flower withers. *In vivo* tests showed that the stigma receptivity lasts for 89 hours. The nectar secreting tubular structure secretes 5 µl of nectar during the life of the flower. The sugar concentration of the nectar varied from 18 to 26%. It contained three common sugars — sucrose, glucose and fructose, in that order of dominance. The nectar also contained amino acids with a histidine score of 5.5 and proteins. The stamens dropped off after 36 hours, sepals and petals after another 36 hours. Then the stigma gradually withered and dropped off 20 hours later. The nectar harbouring tubular structure remained throughout fruit formation and fell off subsequently.

Breeding behaviour: Hand-pollination tests for the modes of breeding showed that the plant does not breed through autogamy but through geitonogamy and xenogamy; geitonogamy is less successful than xenogamy (Table 1). The fruiting success rate in open-pollinated flowers is limited, compared to the success rate of hand-pollinated flowers (Table 2).

TABLE 1
RESULTS OF BREEDING EXPERIMENTS FOR *CADABA FRUTICOSA*

Treatment	No. of flowers pollinated	No. of flowers set fruit	No. of ovules set seed	Fruit set (%)	Seed set (%)	Fecundity (%)
Autogamy	25	0	0	0	0	0
Geitonogamy	25	21	126	84	54	46
Xenogamy	25	23	207	92	82	75

TABLE 2
NATURAL FRUIT, SEED AND FECUNDITY RATES IN *CADABA FRUTICOSA*

Study area	No. of flowers observed	Fruit set (%)	Seed set (%)	Fecundity (%)
Outside Zoo Park	145	14	76	16
Inside Zoo Park	189	5	58	3
Interiors of Zoo Park	98	15	93	8

TABLE 3
PERCENTAGE OF BUTTERFLY SPECIES VISITS TO *CDABA FRUTICOSA* FLOWERS

Date of observation	Mean temp.	Mean relative humidity	*Colotis eucharis*	*Colotis danae*	*Anaphaeis aurota*
Oct. 1, 1999	28.3	67	70	20	10
Nov. 18, 1999	25.6	74	73	13	14
Nov. 30, 1999	25.2	83	91	7	2
Dec. 11, 1999	24.3	68	90	8	2
Apr. 9, 2000	25.6	83	49	19	32

TABLE 4
PROBOSCIS LENGTH OF DIFFERENT BUTTERFLY SPECIES VERSUS NECTARIAL TUBE LENGTH OF *CADABA FRUTICOSA*

Butterfly species	No. of samples	Mean (mm)	Nectarial tube length (mm)
Colotis eucharis	5	17	
C. danae	5	17	10
Anaphaeis aurota	5	20	

Flower-visitors and pollination: The pierid butterflies *Colotis eucharis*, *C. danae* and *Anaphaeis aurota* are the exclusive foragers on *Cadaba fruticosa*. They foraged for nectar from 0630-1500 hrs, with intense activity between 0900 and 1200 hrs. Of these, *Colotis eucharis* is the most frequent and regular forager and made an outstanding percentage of visits during the study period. *C. danae* came second, and made more visits than *A. aurota* (Table 3).

Colotis eucharis and *C. danae,* with an average proboscis length of 17 mm each and *A. aurota* with an average proboscis length of 20 mm probed and succeeded in obtaining the nectar from the nectarial tube (Table 4). To obtain the nectar, butterflies land on the nectarial tube itself or the androgynophore or petals. In this case, they landed mostly on the androgynophore. Contact between anthers and stigma, and the wings of foraging butterflies takes place if they use the androgynophore or nectarial tube; even this contact is achieved only when the gynaecium is erect and stands parallel to the level of the anthers. No such contact is made if the butterflies land on the petals. Examination of the 119 foraging visits of butterflies to the 20 open flowers indicated that wing contact with the anthers and stigma was made in only 66 and 47 visits respectively, while in 6 visits no contact was made with either. The butterflies visited an average of 2-4 flowers per foraging bout. *C. eucharis* foraged more flowers per minute compared to *C. danae* and *A. aurota* (Table 5). All three butterfly species foraged flowers of different conspecific plants very frequently. Only those visits where there was contact between the stigma and anthers resulted in pollination. Since the plant lacks autogamy, such visits are required to bring about either geitonogamy or xenogamy.

TABLE 5
TIME SPENT BY THE BUTTERFLIES AT THE FLOWERS OF *CADABA FRUTICOSA*

Butterfly species	No. of flowers visited in a single bout ($\bar{x}$)	No. of visits per minute ($\bar{x}$)	Average time spent per flower (sec)
Colotis eucharis	4.0	6.5	1.2
C. danae	2.0	4.6	2.0
Anaphaeis aurota	2.3	3.3	3.1

DISCUSSION

Butterfly pollination has been reported in *Rhianthus hirsutus* (McLean and Cook 1956), *Asclepias syriaca* (Percival 1965), *Phlox* species (Grant and Grant 1965, Levin and Berube 1972), *Dianthus* and *Gymnadenia* (Proctor and Yeo 1972), *Anguria* (Gilbert 1975), *Platanthera ciliaris* (Smith and Snow 1976), *Caesalpinia pulcherrima* (Cruden and Hermann-Parker 1979), *Cnidoscolus urens* (Bawa *et al.* 1983) and *Tridax procumbens* (Balasubramanian 1989). In *Cadaba fruticosa* also, floral characters such as opening of the flower during daytime, production of a good amount of nectar, a separate nectar-hosting tubular structure, and a nectarial tube, androgynophore and petals providing a platform for landing, all conform to psychophilous pollination syndrome *sensu* Meeuse and Morris (1984).

C. fruticosa exhibits weak protandry and the anthers are viable for a short period when compared to the lengthy duration of stigma receptivity. This floral sexual behaviour facilitates autogamy for a brief period; but hand pollination tests showed the absence of autogamy. Further, the hand pollination tests performed for geitonogamy and xenogamy showed that the plant is capable of breeding through these two modes of reproduction, xenogamy being more successful. The study of breeding behaviour reveals that pollen flow between flowers of the same or conspecific plants is imperative for geitono- or xenogamous pollination.

The flowers of *C. fruticosa* with psychophilous characters have been observed to be foraged and pollinated exclusively by three pierid butterfly species, namely *Colotis eucharis*, *C. danae* and *Anaphaeis aurota*. The foraging behaviour, mobility rate and foraging frequency of these three butterflies were seen to effect geitono- and xenogamous pollination, and on this basis, these butterflies may be treated as exclusive pollinators. However, *C. eucharis* with its greater foraging frequency is a dominant pollinator. The nectarial tube of the flower is perfectly tailored to the length of the butterfly's proboscis, enabling *C. eucharis* to withdraw the nectar easily while excluding other flower-visitors. Although the flower is exclusively suited for butterfly pollination, butterflies do not effect pollination in each visit. Of the total visits, only 40% effect pollination, 55% carry pollen and 5% simply deplete nectar. The butterflies contact the stigma and anthers with their wings only, and this contact is directly related to the place of landing on the nectarial tube, androgynophore and petals, and also to the relative position between them. The butterflies effect pollination or carry pollen only if they use either the nectarial tube or the androgynophore. Even this pollination is effected only when the gynaecium is erect and stands parallel to the level of the anthers. These limitations, and the observed foraging frequency of butterflies, are bound to influence natural reproductive success. The natural fruit set, seed set and fecundity rates recorded in the study are in tune with the above observations. Nevertheless, and whatever be the limitations, *C. fruticosa* is an excellent example of psychophilous pollination syndrome.

C. fruticosa flowers almost throughout the year and the butterflies forage on this plant all through the year for their nectar requirement, while occasionally foraging on associated plant species such as *Tridax procumbens*, *Justicia*

procumbens, *Borreria hispida* and *Lantana camara,* which flower largely in the rainy season. The study clearly indicates that *Cadaba fruticosa* is the adult's principal nectar host plant. Further, it is found that the two *Colotis* butterflies oviposit on the leaves and flower buds of *C. fruticosa* and their larvae feed on the same leaves. On the other hand, *Anaphaeis aurota* does the same on *Capparis spinosa*, which occurs in the same study area. Therefore, the study considers the plant *Cadaba* and the pierid butterflies belonging to *Colotis* as a co-evolved system. The *A. aurota* - *C. fruticosa* system appears to be a one sided adaptation, as the plant allows only butterflies of *A. aurota* to feed on its nectar and pollinate it, and not the larvae.

The *C. fruticosa-Colotis* relationship appears to be a specialized system and any disturbance in the habitat is bound to affect the existence of both. It is imperative to protect the habitats where these two partners occur, in order to ensure their perpetuation.

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A DICHOTOMOUS KEY FOR FIELD IDENTIFICATION OF THE ORDERS OF INDIAN DIPLOPODA[1]

KUBRA BANO[2]

(*With ten text-figures*)

Key words: Taxonomy, Diplopoda, Identification, Dichotomous Key, Orders, Families

This paper is intended as a guide for identification of Indian diplopods, at least to their Orders. The Indian diplopod fauna, so far known, consists of 11 orders, 20 families, and 100-120 genera, with approximately 500 species. Many more might be unlisted because of lack of expertise. A key for identification has been provided.

INTRODUCTION

Diplopods are some of the most frequent fauna of Tropical, Subtropical, Temperate Forest floors and other ecosystems. Despite their frequent occurrence, they have evinced very little interest among zoologists, even less among systematists, especially in India. They are the most neglected group compared to the Insecta and Arachnida, and are scarcely studied, perhaps due to lack of expertise.

Hoffman (1979) reported Diplopoda of the world, comprising 10,000 species under 15 orders, 115 families and over 1,700 genera. Studies on Indian diplopods date back to the pre-independence era, and since then have not been updated. Attems (1936) reported 290 species from Indian Territory. Carl (1941) added 15 species. In the last 3 decades, a few sporadic reports that appeared were those of Demange (1961, 1969, 1970, 1975, 1977a, b, 1983 and 1989), Jeekel (1968 and 1980), Hoffman (1977), Hoffman and Burkhalter (1978), Golovatch (1983, 1992 and 1993), and Golovatch and Martens (1996). The Indian diplopod fauna known today consists of 11 orders, 20 families and about 100-120 genera with around 500 species. A note on their general characters, collection and preservation has already been published elsewhere (Bano 1999).

During the last 3 years, the author, while working on the systematics of Indian diplopod families, Harpagophoridae and Paradoxosomatidae felt the need to update the key, and has now attempted to bring out a concise and illustrated key for their identification. A brief account of the characters and distribution is added.

CLASS DIPLOPODA

Characters: Diplopods are commonly called millipedes, meaning 'thousand legs', although no individual of this group bears a thousand legs, their many legs and wave-like motion has given them the name millipede.

Diplopods are defined as many-segmented, many-legged, terrestrial, tracheate, mandibulate, antennate, progoneate, oviparous and anamorphic arthropods. They are long, cylindrical or sub-cylindrical, excepting a few dorsoventrally flattened forms (Polydesmida and Chodeumatida). Body measures from 2.0 mm (Polyxenida) up to 200 mm in length (Spirostreptida, Spirobolida and Julida). The outer body covering is a hard chitinous, shiny and beautifully coloured exoskeleton, except in

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Polyxenida. The body consists of an anterior head capsule, bearing one pair of 8-jointed antennae. Just behind the antennae, at the sides or more rarely on the middle of the forehead, are a group of simple eyes or ocelli. Ocelli may be numerous or reduced to 5, 3 or even 1 on each side, or completely absent as in the case of Polydesmida, Siphonophorida and in some cave-dwelling forms. Between the eyes and the antennae is a small sensory pit. The frontal margin of the head is the labrum or the clypeus, which is notched at the middle, usually bearing three teeth. Underneath are a pair of mandibles carrying powerful cutting edges, at the base of which are placed a pair of maxillae which are fused, forming a plate called gnathochilarium acting as a labium, or floor of the buccal cavity. Diplopoda is unique among arthropods in possessing a gnathochilarium.

The head is followed by a long, segmented trunk. The segment immediate to the head capsule is the colium, large, devoid of legs and with paired sternites. Following this are three segments bearing three pairs of legs. The remaining body segments are made up of two somites each (diplosomite), the anterior prozonite and the posterior metazonite. The diplosomites carry two pairs of legs. The last segment lacks legs and is called the telson or the pygidium. The telson ends in a long or short, sharp or blunt spine, bent upward, or downward, or straight. Most of the millipedes are equipped with defence glands, the repugnatorial glands or the ozadenes, opening through ozopores located laterally on the metazonites and distributed on most of the body segments, except a few anterior and tail segments. The secretions of these glands are odoriferous, highly volatile compounds of hydrogen cyanide, phenols, iodides, terpenoids, quinones and aldehydes, which act as a deterrent to other animals.

All the diplopods are progoneate; the genital ducts of both sexes open on ring iii. In males of spirostreptids, spirobolids, julids stemmiulids and polyzonids, the paired deferent canals open into a median penis or paired penes behind the second pair of legs. In glomerids, chordeumatids and polydesmids, the deferent canals perforate the coxae of the second pair of legs. In females of all orders, each oviduct opens separately into a vulva or cyphopod behind the second pair of legs. Each vulva consists of a bivalve bursa with an anterior opening covered by an operculum. Within the bursa is the apodermatic tube terminating with one or two ampullae, which function as seminal receptacles or spermathecae. Each vulva lies in a sac sunk into the lumen of the ring behind the second pair of legs. The sac and the vulva are everted during copulation.

Distribution: Diplopods are abundant in warm humid tropics and all temperate broad leaf forest regions of the world (Hoffman 1990). They occur from the snow line down to sea level, and some are cave and sand dune dwellers. They are primarily inhabitants of forest floors and the relic fauna is found to have established in plains, cultivated lands, grasslands, and gardens. Their distribution is contiguous; they are found in large aggregates, small numbers or in singles, crawling aimlessly on the verges of roads or in open fields and plain lands, or lying spirally coiled under litter or mineral soil. They are active on the surface during the monsoon after one or two showers (April to June and October to December).

Systematic and faunistic knowledge of Indian Diplopoda is poor, archaic and incomplete. The fauna reported so far is chiefly from the northern Himalayan regions and southern Peninsula. The majority of the Himalayan fauna is localized in distribution, restricted to certain altitudes, and very few species are widespread (Golovatch and Martens 1996). Among the diplopods, worldwide distribution is very rare. According to Attems (1936), the Indian diplopod fauna is largely endemic, and bears a close relationship to the

African, and to a certain extent to the Australian fauna. But the majority of the fauna is endemic and localized. Among the Harpagophoridae, the genus *Gonoplectus* is specially restricted to the northern Himalayan region, whereas the other genera such as *Harpurostreptus*, *Carlogonus*, *Gnomognathus*, *Organognathus*, *Ktenostreptus* and *Phyllogonostreptus* are largely of Peninsular India. Sphaerotherids are reported from both the regions, but are restricted to high altitudes. The millipedes of the Orders Chordeumatida, Julida and the genera of Family Furhamonodesmidae, Order Polydesmida, are reported only from Himalayan ranges, whereas the other three families of Polydesmida are reported from both the regions. Thus, diplopods exhibit biogeographic affinities.

Dichotomous key for the Orders of Class Diplopoda

1. Body wall membranous without sclerotisation. Body soft, consists of 11 segments with 13 pairs of legs, covered with tufts or clusters of setae or bristles. Males without copulatory organs (gonopods). Minute animals of 2-3 mm length. Found in dry places. Commonly called 'bristly' millipedes (Fig. 1) .... Polyxenida.
Family: Polyxenidae
(1 species reported from Kashmir, 1 species reported from South India)

— Body wall sclerotised. Body hard, composed of 13 or more segments. Setae, if present, always single and simple, never in tufts or clusters. Adults with 17 or more pairs of legs. Tarsal claw simple and acute. At least one pair of legs modified into copulatory organs (gonopods) in males 2

2. Dorsal surface of body slightly convex. Adults with 13 or 22 segments. Segmental sclerites loosely attached (pentazoneate, Fig. 2a). No plural keels. Last pair of legs modified into copulatory organs 3

— Body flat or sub-cylindrical. Adults with 19 or more segments. Segmental sclerites completely fused to form a tight ring (monozoneate, Figs 2b, 2c and 2d) or attached with membranous joints. Paired legs on 7th segment modified into gonopods in males 5

3. Body composed of 13 segments. Head with a row of ocelli (eyes). Animals capable of rolling into tight balls or spheres. Males stridulate by rubbing last pair of legs with sides of last tergite 4

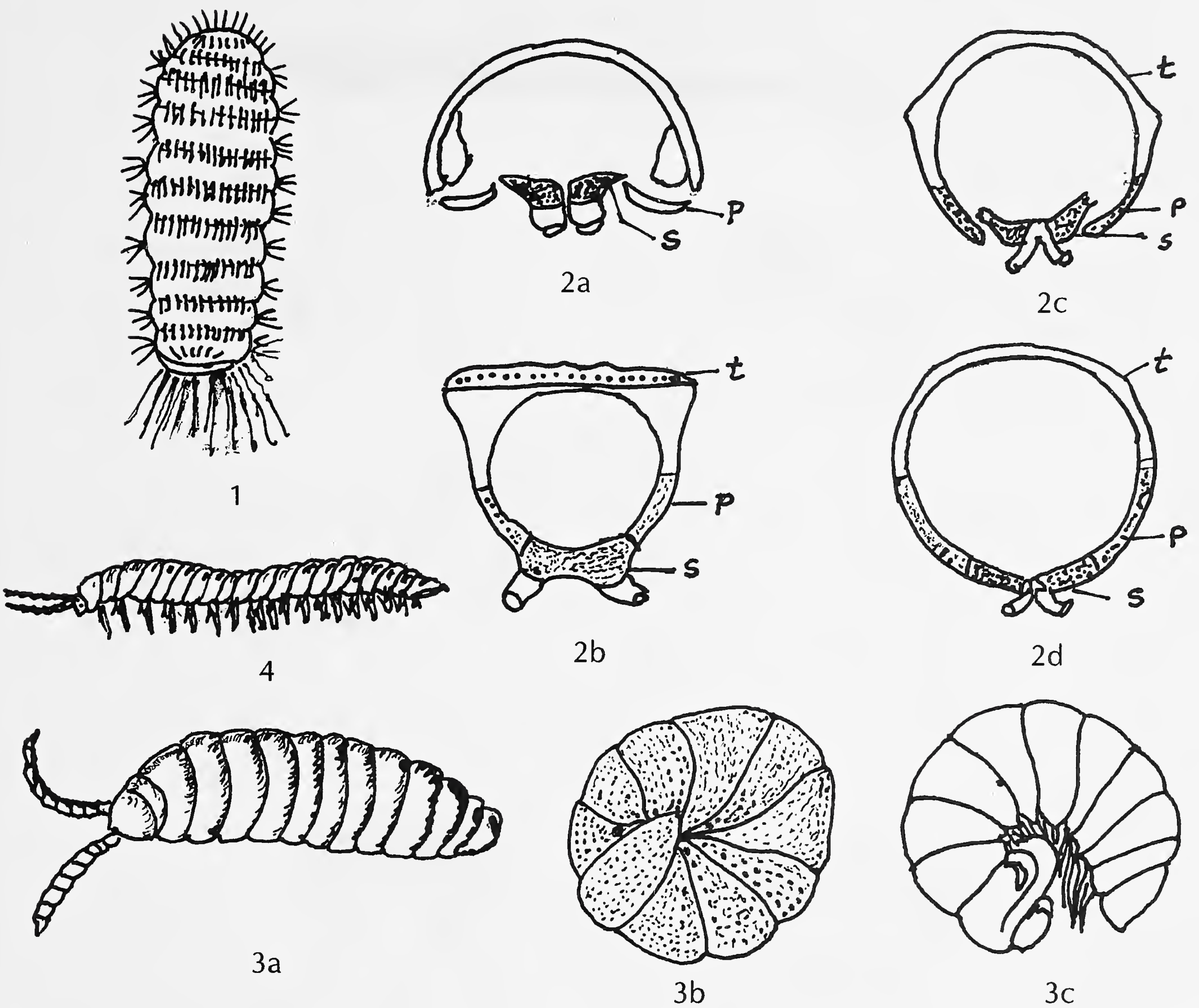
— Body composed of 22 segments. Head without ocelli. Animals not capable of rolling into a ball or sphere, males do not stridulate .... Glomeridesmida
Family Glomeridesmidae
(2 species known from South India)

4. Animals large, up to 8 cm. Body surface smooth, grey to black in colour without any ornamentation, called 'giant pill millipedes' (Figs 3a and 3b) .... Sphaerotheriida.
Families Sphaerotheriidae and Sphaeropoeidae
(More than 30 species reported from India)

— Animals small, up to 2 cm. The 2nd and 3rd body segments fused to form a broad plate (Fig. 3c) laterally, accommodates the lateral tip of the following terga during ball formation. Cuticle jet black, sometimes with brightly coloured spots .... Glomerida
Family Glomeridae
(3 species reported from North India)

5. Body flattened, sub-cylindrical, with 19 segments. Segmental sclerites fused into a single solid ring, usually without traces of sutures (Fig. 2b). Ocelli always missing. Gonopod formed from only the anterior pair of legs of the 7th segment, posterior pair of legs absent (Fig. 4) .... Polydesmida
Families Paradoxosomatidae, Fuhrmannodesmidae, Pyrgodesmidae and Cryptodesmidae
(More than 60 species known from India)

— Adults with 26 or more segments, not completely coalesced. Sterna and pleura joined by a membrane, or with a distinguishable suture (Figs 2b and 2c). Both pairs of legs of 7th segment modified into gonopods. If the gonopod is modified from a single pair of legs, the sterna not coalesced with pleuroterga, and the latter ornamented with longitudinal ridges (Figs 5b and 5c) 6

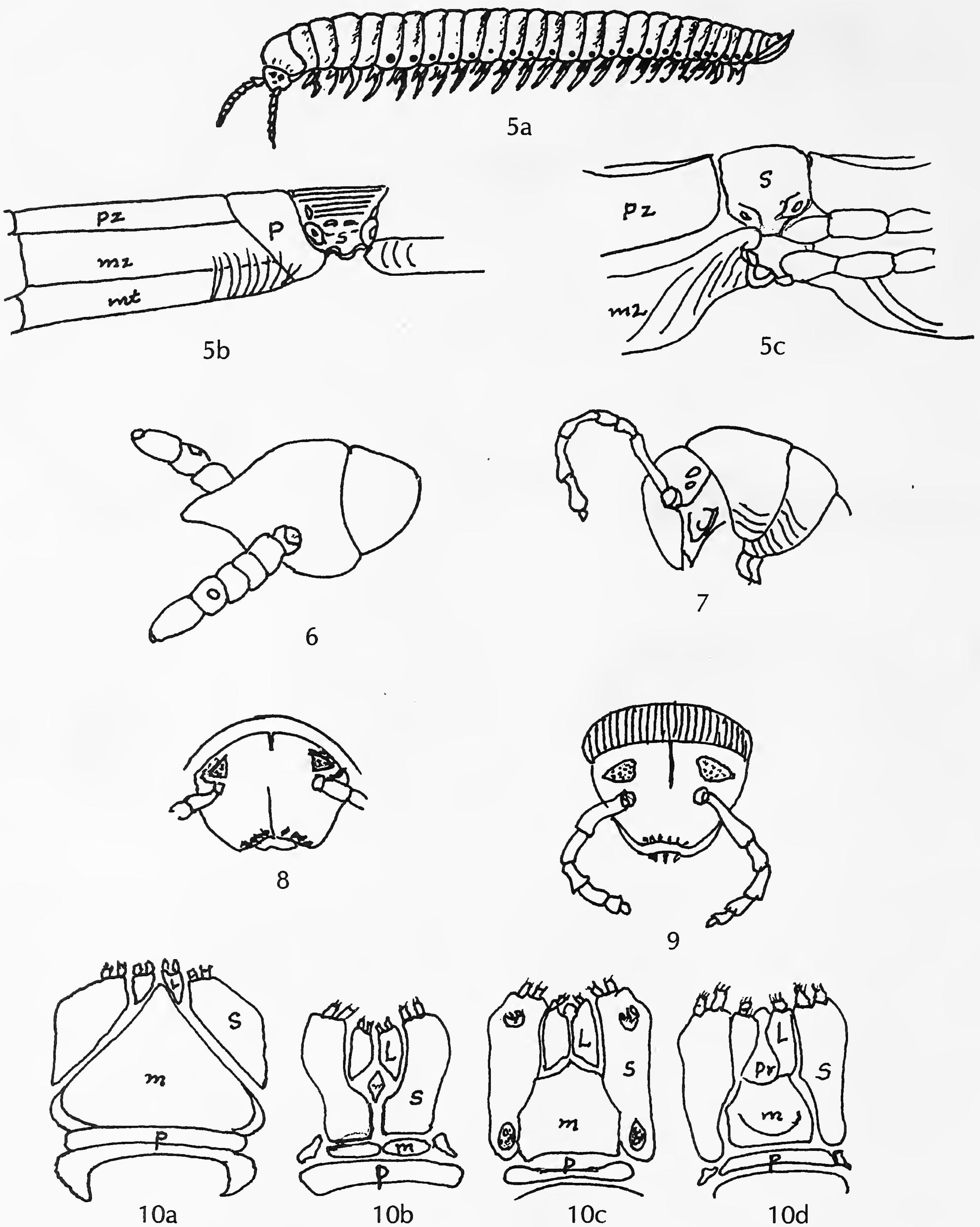


Figs 1-4: 1. *Polyxenus* (Dorsal View), 2. Cross sections of segments of: a. Glomerid, b. Polydesmid, c. Chordeumatid, and d. Spirostreptid. (s: sternite; p: pleurites; t: tergites), 3. *Arthrosphaera* (Sphaerotheriida): a. extended animal, b. rolled into a ball, 3c. *Glomeris* (Glomerida) curled up, 4. *Anoplodesmes tanjoricus* (Polydesmida)

6. Head variable in form, usually as broad as the collum, without ocelli, anteriorly produced into a beak or rostrum. Body setose, thin and long. Large number of segments (180-190), with simple gonopods. Antennae straight, distal article enlarged. Article 5 with sensory pit (Fig. 6). Metaterga without longitudinal suture. Sterna and pleura flexibly articulated by connective tissue .... Siphonophorida
Family Siphonophoridae
(2 species from South India and 1 from North India)

— Head smooth, rounded, without beak or rostrum. Body straight, arched or cylindrical, with 26 or more segments. Antennae without sensory pits. Sterna, pleura and terga completely coalesced into rigid cylindrical rings 7

7. Body with 26-30 segments in adults. Arched or sub-cylindrical. Sternites not coalesced (Fig 2c). Ozopores absent. Ninth and tenth



Figs 5-10: 5a. *Phyllogonostreptus nigrolabiatus* (Spirostreptida), 5b. Body segment (ventral view) spirobolid, c. Body segment (ventral view) Spirostreptid, 6. Head with collum (lateral view) Siphonophorid, 7. Head with a few segments (lateral view) Stemmiulid, 8. Head (front view) with clypeal suture Spirobolid, 9. Head (front view) with occipital suture Spirostreptid, 10. Gnathochilarium: a. spirobolid, b. julid, c. spirostreptid, d. cambalid, (s. stipes, l. linguales, m. mentum, p. prementum)

pairs of legs with coxal sacs in males. Metaterga with 3+3 macrochetae and with external swellings or keels. Epiproct with spinnerets .... Chordeumatida

Family Cleidogonidae and Kashmireumatidae

(2 species known from North India)

— Body with more than 30 segments, cylindrical. Metaterga without keels and macrochaetae. Epiproct without spinnerets, but with or without a simple spine 8

8. Head with one or two large ocelli on each side (Fig. 7). Pleurites and tergites fused. Metatergal suture prominent ....
.... Stemmiulida

Family Stemmiulidae

(3 species known from South India)

— Head with numerous ocelli in ocular field, or ocellaria. Ocular field triangular / reniform or oval. Segmental sclerites fused into a complete ring 9

9. Ocular field rounded or oval. No occipital suture between them, but clypeal suture evident (Fig. 8). Pleural sclerites distinct (Fig. 5b). A single pair of legs up to 5th segment. Gnathochilarium with a broad mentum separating the bases of the stipes and lingulae from each other (Fig. 10a) ...
.... Spirobolida

Families Spirobolidae, Pachybolidae and Physobolidae

(More than 30 species reported from South India)

— Ocular fields reniform or subtriangular, usually with a fine occipital suture between them (Fig. 9), clypeal suture absent. Pleural sclerites completely fused with the lower end of terga. No suture in between (Fig. 5c). Segment 4 without legs. Gnathochilarium variable 10

10. Large millipedes up to 15-20 cm in length, with up to 90 segments (Fig. 5a). Occipital suture evident. Pleural sclerites indistinct. 4th segment without legs. Male gonopods consist of both pairs of legs of 7th segment, anterior pair more active. Stipes of the gnathochilarium always widely separated by a large median mentum (Figs 10c and 10d)
.... Spirostreptida

Families Spirostreptidae, Harpagophoridae, Cambalidae (Fig. 10d) and Adiaphorostreptidae

(More than 70 species known from India)

— Small cylindrical millipedes. Bases of the stipes of gnathochilarium broadly in contact medially. Small prominent sclerites, a promentum isolates the stipes from the linguales. Mentum, a transverse large plate (or 2 plates) present at the bases of the stipes (Fig. 10b) the male gonopods formed from both pairs of legs on the 7th segment........
.... Julida

Family Julidae

(1 species reported from North India)

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Appendix

Field Identification of Orders of Class Diplopoda

1. Body soft, with tufts of setae .... Polyxenida
— Body hard, no tufts of setae 2
2. Adults at most with 13-22 body segments 3
— Adults with 26 or more body segments 6
3. Body flat. Adults with 20 segments. Segmental sclerites fused into a complete ring (monozoneate), tergites usually with lateral wings or keels .... Polydesmida
— Body subcylindrical, each segment with a tergite, two pleurites and two coxosternites freely attached (pentazoneate); no lateral keels 4
4. Adults with 22 segments. Head without ocelli, animals unable to roll into a ball .... Glomeridesmida
— Adults with 13 segments. Head with a row of ocelli, animals roll into a ball 5
5. Large animals, grey to black in colour, without ornamentation (giant pill millipedes) .... Sphaerotheriida
— Small animals, jet black colour, some with bright coloured spots, 2nd and 3rd body segments fused into a broad plate .... Glomerida

6. Head without ocelli, anteriorly produced into a beak or rostrum. Body densely hairy (pilose), thin, long with large number of segments .... Siphonophorida

— Head smooth, rounded, without beak or rostrum, ocelli normally present. Body smooth 7

7. Body arched, with 26-30 segments without ozopores, metaterga with keels 3+3 macrochaetae, epiproct with spinnerets .... Chordeumatida

— Body cylindrical, with more than 30 segments, metaterga without keels, no macrochaetae, epiproct with simple spine, no spinnerets 8

8. 1 or 2 big ocelli on each side of head, pleurotergites with middorsal suture .... Stemmiulida

— Several small ocelli, ocular fields triangular, reniform or oval, segmental sclerites fused into a complete ring (monozoneate) 9

9. Head with a median clypeal suture, ocular fields rounded or oval .... Spirobolida

— Head with occipital suture, ocular fields triangular or reniform 10

10. Large millipedes, head with occipital suture, stipites of the gnathochilarium separated by a large mentum .... Spirostreptida

— Small millipedes, body up to 1.5 cm long, stipites of the gnathochilarium meeting in midline, mentum small transverse plate or 2 plates at the bases of the stipites .... Julida

■ ■ ■

NEW DESCRIPTIONS

STUDIES ON *OXYSYCHUS* DELUCCHI, HYMENOPTERA: CHALCIDOIDEA: PTEROMALIDAE, FROM INDIA WITH THE DESCRIPTION OF A NEW SPECIES[1]

P.M. SURESHAN[2] AND T.C. NARENDRAN[3]

(*With fifteen text-figures*)

Key words: Chalcidoidea, Pteromalidae, *Oxysychus*, *O. macregaster* sp. nov.

The species of *Oxysychus* Delucchi, namely, *O. coimbatorensis* (Ferriere), *O. nupserhae* (Dutt & Ferriere), *O. sphenopterae* (Ferriere) from India are reviewed and one new species *O. macregaster* sp. nov. is described. A key to the species of *Oxysychus* from India is also provided.

INTRODUCTION

The genus *Oxysychus* Delucchi is well known from the Ethiopian, European and Oriental Regions. In India, this pteromalid genus is represented by *O. sphenopterae*, *O. coimbatorensis*, *O. nupserhae* and a new species *O. macregaster* which is described here. The observations on some character variations of propodeum, and number of tibial spurs are discussed. The diagnostic characters and illustrations of the species known from India are also provided.

The terminology in this paper generally follows Graham (1969). The antennal funicular segments are numbered F1-F5 and the gastral tergites T1-T6, beginning with the first after the petiole and the last before the epipygium. The following abbreviations are used: OOL-Ocello-ocular distance; POL - post-ocellar distance; SMV-submarginal vein; MV- marginal vein; PMV - post marginal vein and STV - stigmal vein.

The type specimens have been deposited with the Zoological Survey of India, Calicut.

Oxysychus Delucchi

Oxysychus Delucchi, 1956. *Z. angew. Ent.* 39: 240. Type species *Dinarmus silvestri* Masi, by original designation.

This plesiomorphic genus of Pteromalidae has a sessile gaster, extensive pilosity on the dorsal thorax and two spurs on the hind tibia (Boucek 1988). The other generic characters are: carinate pronotal collar; propodeum between spiracles almost flat or weakly convex; antenna in female with 3 anelli and 5 funicular segments, and in male 2 and 6 respectively. But our observations on the type specimen of *Oxysychus sphenopterae* revealed some variations in the above characters, such as hind tibia with one spur and propodeum with a weak median carina obliterated in the middle by an obscure cross ridge. We have not seen further material of *Oxysychus sphenopterae*, hence refrain from commenting on these variations. The hind tibial spurs are usually double and one may become rudimentary in *Oxysychus sphenopterae* as given by Mani (1989). Some specimens of *Oxysychus macregaster* sp. nov. also show variation in possessing a weak and complete median carina on propodeum, which is either absent or only slightly indicated anteriorly.

KEY TO THE INDIAN SPECIES OF *OXYSYCHUS* DELUCCHI

1. Gaster with hind margins of T1-T3 medially produced and distinctly notched in the middle (Fig. 14); antennae slender (Fig. 12); forewing with PMV 2x STV; all femora testaceous .... *macregaster* sp. nov.

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— Gaster with hind margins of T1-T3 not produced or notched as above; antennae not very slender (Figs 2, 5, 8); PMV shorter, less than 2 x STV; femora brown to blackish-brown (prominent on hind femora) 2

2. Hind tibia with one spur; scutellum almost flat (Fig. 7); antennae with scape not reaching above level of vertex; propodeum (Fig. 10) with a weak median carina obliterated in the middle by an obscure cross ridge; forewing with STV slightly curved .... *sphenopterae* (Ferriere)

— Hind tibia with two distinct spurs; scutellum convex; scape reaching above level of vertex; propodeum without median carina and cross ridge; STV not curved 3

3. Gaster elongate, pointed at tip and distinctly narrower than thorax (Fig. 1); scutellum highly convex, almost as long as broad; antenna (Fig. 2) with club shorter than two preceding segments combined; STV shorter, only one third of MV .... *coimbatorensis* (Ferriere)

— Gaster oval (Fig. 4), not narrower than thorax; scutellum less convex, shorter than broad; club a little longer than two preceding segments combined; STV longer, almost half of MV .... *nupserhae* (Dutt & Ferriere)

Oxysychus coimbatorensis (Ferriere) (Figs 1-3)

? *Dinarmus sauteri* Masi, 1926. *Konowia* 5: 360. Farooqi & Subba Rao, 1986: 296 (Synonymy).

Dinarmus coimbatorensis Ferriere, 1939: 164. Boucek *et al.* (1979): 449 (New combination).

Farooqi & Subba Rao (1986) placed *Dinarmus sauteri* Masi under *O. coimbatorensis* with a question mark. We have examined the lectotype of *O. coimbatorensis* (Ferriere) and several freshly collected specimens. As the original description by Ferriere is fairly good, only diagnostic characters of the species are given here. Female: Length 2.5-5 mm. Head and thorax dark bluish-green; gaster aeneous, shining green at base; body stout, covered with distinct white pubescence; head and thorax reticulate punctate. Antennae (Fig. 2) with length of F1 being 2x length of pedicel; club stout, oval, shorter than two preceding segments combined. Thorax (Fig. 1) convex; scutellum broadly rounded at tip, almost as long as broad; propodeum without median carina; forewing (Fig. 3) with MV 3x STV; PMV almost 2x STV. Gaster (Fig. 1) elongate, longer than head plus thorax, narrower than thorax. Some specimens have the last tergites less elongate and the gaster scarcely longer than head plus thorax.

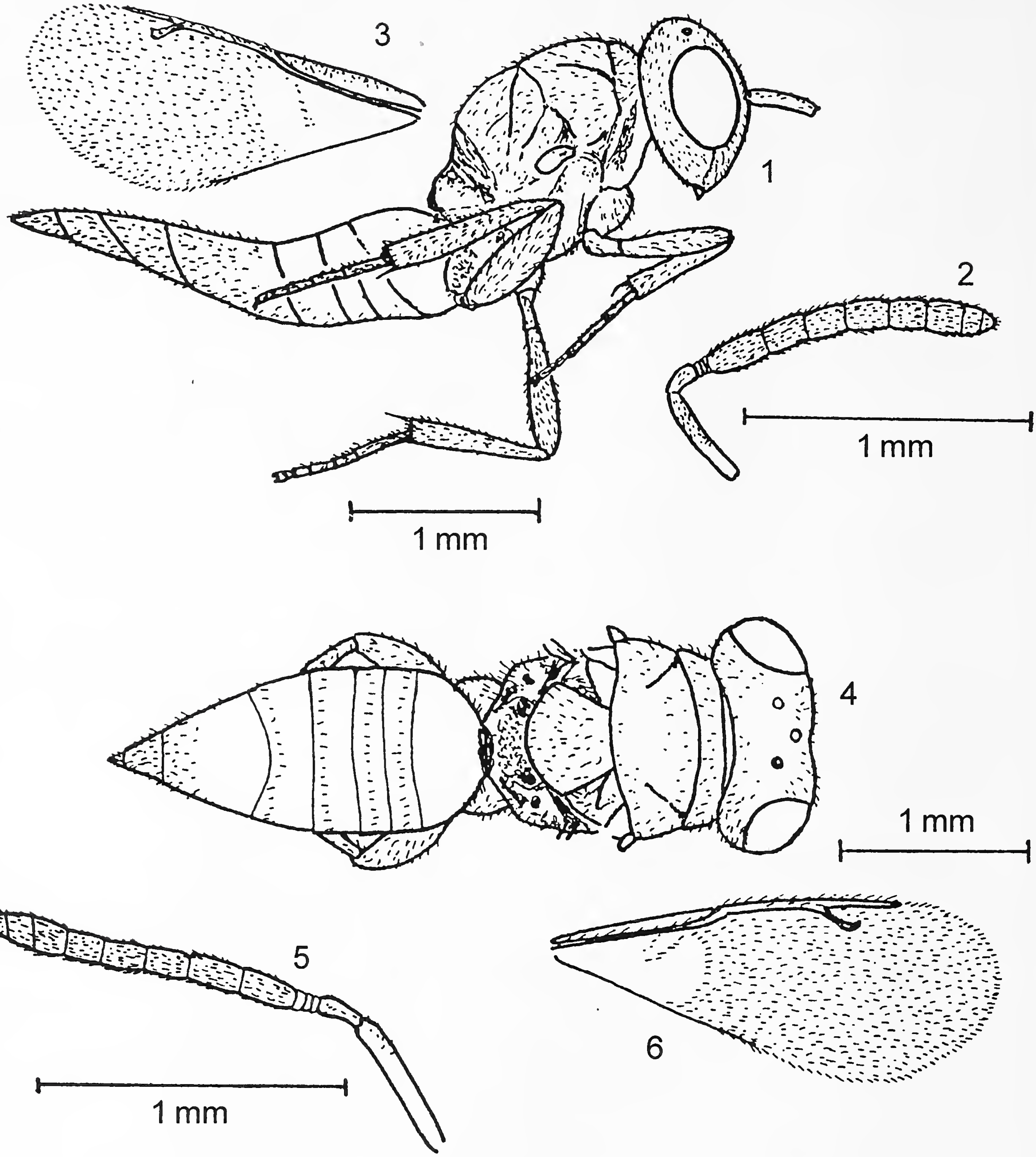
Male: Length 1.5-3 mm. Smaller, differs from the female in having antennae more elongate, with 2 anelli and 6 funicle segments; gaster oval, depressed, shorter than thorax, with a broad yellow spot reaching the middle.

Biology: Parasitic on *Hypolixus truncatulus* (Fabricius), *Pempherulus affinis* (Faust) (Coleoptera: Curculionidae) ex. Stem of *Amaranthus viridis* (Farooqi & Subba Rao 1986).

Distribution: India (Kerala, Tamil Nadu, Andhra Pradesh, Bihar, Delhi) and Pakistan.

Material examined: Lectotype: *Dinarmus coimbatorensis* Ferriere, 1939, ♀; S. India: Coimbatore, iv, vii, viii. 1939, Coll. P.N. Krishna Ayyar, ex. *Pempheres affinis* (British Mus. type. Hym. 5.673).

Other material: 5 ♀, INDIA: Kerala: Calicut University Campus, 14.ii.1985, v.1985, ix.1985 and x.1985, Coll. Narendran & party; 14 ♀, 6 ♂, Calicut University Campus, Coll. P.M. Sureshan 1986-1989; 1 ♀, Thekkady, 11.v.1986; 3 ♀, Parambikulam Wildlife Sanctuary, 22.xii.1985; 2 ♀, Peechi, 29.x.1985, Coll. Narendran & party; 15 ♀ and 2 ♂, Coll. P.M. Sureshan, different parts of Kerala 1986-1989; 2 ♀, Andhra Pradesh: Tenali, 28.ix.1986, Coll. Narendran & party.



Figs 1-3: *Oxysychus coimbatorensis* (Ferriere), Female: 1. Body in profile, 2. Antenna, 3. Forewing

Figs 4-6: *Oxysychus nupserhae* (Dutt & Ferriere), Female: 4. Body in dorsal view, 5. Antenna, 6. Forewing

Oxysychus nupserhae (Dutt & Ferriere)
(Figs 4-6)

Neocatolaccus nupserhae Dutt & Ferriere, 1961. *Indian J. Agr. Sci.* 31: 139. Boucek *et al.* 1979: 450 (New combination).

Diagnostic characters: Female: Length 3-6 mm. Head and thorax dark blue, almost black; gaster aeneous with coppery shine; head with frons swollen; cheeks large; vertex narrow; POL greater than OOL. Antennae (Fig. 5) inserted a little above lower ocular border; scape extends a little above vertex level; third anellus a little longer than others; club a little longer than two preceding segments together. Thorax (Fig. 4) rugulose punctate; pronotum very short; scutellum less convex, shorter than broad; propodeum with lateral folds less prominent; median carina absent. Forewing (Fig. 6) with MV almost half of SMV, STV half of MV. Legs strong; distal tibial ends and tarsi almost whitish. Gaster (Fig. 4) oval, pointed behind, not narrower than thorax, longer than head plus thorax.

Male: Length 2.3-3 mm, smaller than female; antennae with 2 anelli and 6 funicular segments; gaster oval, equal to thorax, depressed, with a brown spot at the base reaching a little beyond middle.

Biology: Parasitic on Cerambycid beetle *Nupserha bicolor* Thomson girdling the stem of Jute (Boucek *et al.* 1979).

Distribution: India (Kerala, W. Bengal, Delhi)

Material examined: 2 ♀, 1 ♂, India: Kerala: Parambikulam Wildlife Sanctuary, 22.xii.1985, Coll. Narendran and party; 1 ♀, Wynad (Nanchal), 10.xii.1994, Coll. P.M. Sureshan; 1 ♂, Kazhakuttom, 25.ii.1989, Coll. P.M. Sureshan; 11 ♀ and 7 ♂, Calicut University Campus, Coll. P.M. Sureshan 1986-1989.

Oxysychus sphenopterae (Ferriere)
(Figs 7-10)

Neocatolaccus sphenopterae Ferriere, 1931. *Bull. Ent. Res.* 22: 130. Boucek *et al.* 1979: 450 (New combination).

We have examined the holotype of this species, the observed diagnostic characters are given below:

Female: Length: 3.3 mm. Head and thorax dark blue, almost black; gaster aeneous with a little greenish reflection on T1; head punctate; lower face swollen; cheeks large. Antennae (Fig. 8) inserted in the middle of face, scape not exceeding above vertex level; third anellus little longer; flagellum thick; club a little shorter than two preceding segments combined. Thorax (Fig. 7) punctate; pronotum very short; mesoscutum flat above; scutellum as long as broad, almost flat; propodeum (Fig. 10) with an obscure median ridge and a weak median carina indicated only anteriorly. Forewing (Fig. 9) with MV half of SMV; STV half of MV, slightly curved. Legs strong, fore femora somewhat thickened; hind tibia with one strong spur. Gaster (Fig. 7) oval, pointed at apex, longer than thorax.

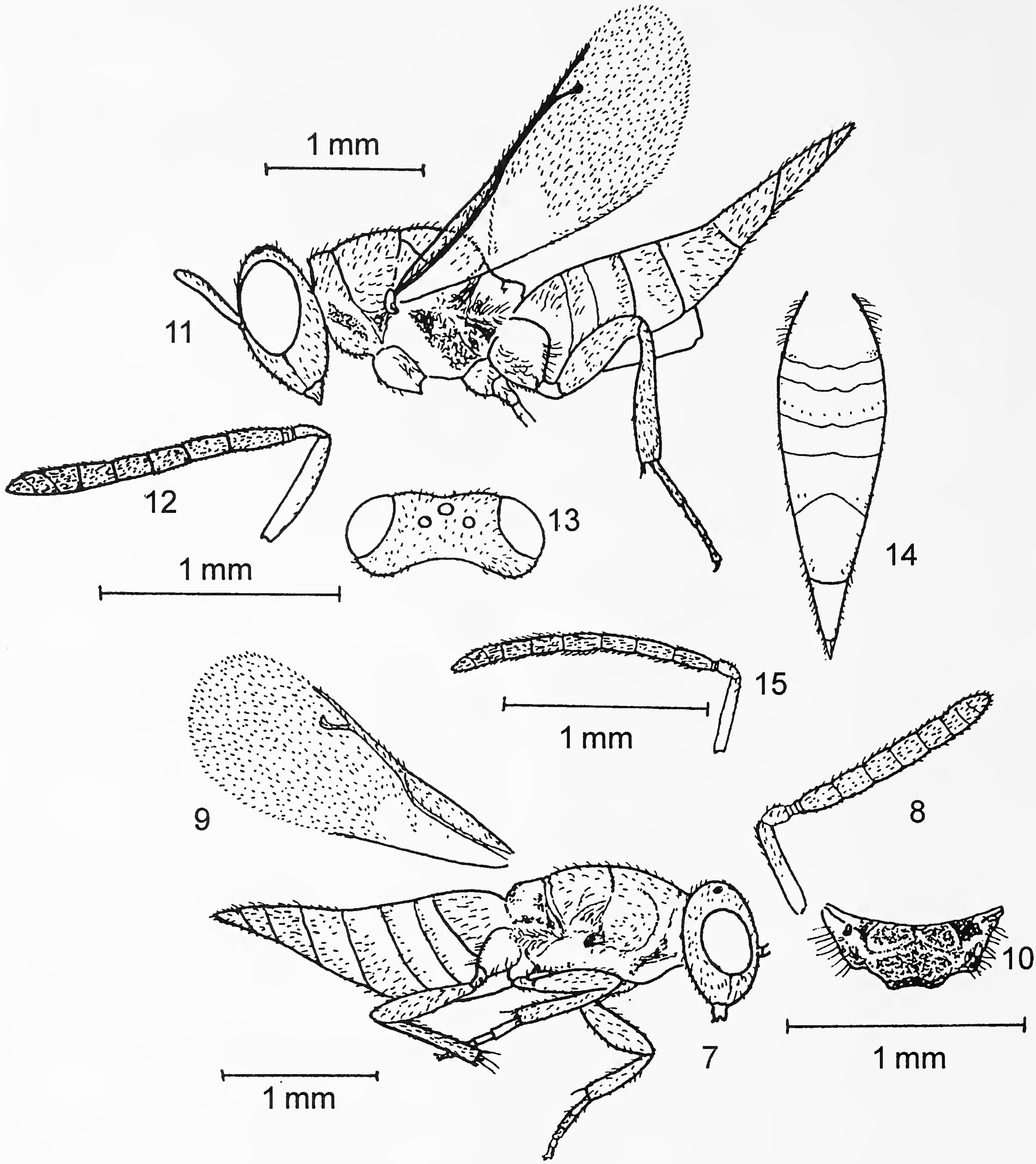
Biology: Reported parasitic on larvae of the Buprestid beetle *Sphenoptera gossypii* from Sudan, Africa (Ferriere 1931). Mani (1938) reported it from the same host from Punjab, India.

Distribution: India (Punjab) and Africa (Sudan).

Material examined: Holotype: ♀ in BMNH having data as follows: B.M. type Hym. 5.692. British Sudan: Wad Medani, 23.i.1925, H.B. Johnston, ex. *Sphenoptera gossypii* Cotes.

Oxysychus macregaster sp. nov.
(Figs 11-15)

Female: Length 2.9-4.0 mm (Holotype 3.7 mm). Head and thorax bluish-black; gaster aeneous with bluish reflection on T1; antennae testaceous, except club, F1 and F5 brownish; coxae concolorous with thorax, except middle coxae brown, remainder of legs testaceous except tips of tarsi brown; tegulae brown; wings hyaline; veins pale brown.



Figs 7-10: *Oxysychus sphenopterae* (Ferriere), Female: 7. Body in profile, 8. Antenna, 9. Forewing, 10. Propodeum in dorsal view
Figs 11-15: *Oxysychus macregaster* sp. nov., Female: 11. Body in profile, 12. Antenna, 13. Head in dorsal view, 14. Gaster in dorsal view, 15. Male antenna

Head (Figs 11, 13): Moderately reticulate; clypeus striated. In dorsal view, head width 2.1x length and in front view width 1.3x height; temple length 0.2x eye length; POL 1.5x OOL; eye length 1.5x width in profile; malar space half of eye length; clypeus bidentate. Antennae (Fig. 12) inserted a little below middle of face; scrobe deep; antennae slender; scape 0.9x eye length; pedicel length 2x width; third anellus a little longer than others; club as long as two preceding segments together. Relative lengths of F1 to F5 : : 10 : 7 : 6.5 : 6.5 : 6.

Thorax (Fig. 11): Raised reticulate; pronotum finely margined. Mesoscutum width 2x length; notauli reaching up to middle. Scutellum convex, a little wider than long (20.5 : 18.5). Propodeum with no median carina (some specimens have a weak median carina which is also either incomplete or absent). Prepectus finely reticulate. Forewing (Fig. 11) with basal vein pilose; costal cell with upper half hairy. Relative lengths of SMV, MV, PMV and STV : 36.5 : 22.5 : 16.5 : 8. Legs slender; hind femora length 3.5x width and shorter than tibia (0.9x); hind tibia with two spurs.

Gaster (Figs 11, 14): Elongate, acuminate, longer than head plus thorax (60 : 44.5); hind margins of T1-T3 slightly produced and notched in the middle.

Male (Fig. 15): Length 3.1 mm. Smaller than female; differs from female in having antenna with 2 anelli and 6 funicle segments; ocelli larger and gaster shorter, compressed, shorter than head plus thorax with a broad yellow spot reaching the middle.

Distribution: India (Kerala).

Material examined: Holotype: ♀, INDIA: Kerala: Calicut University Campus, 24.x.1986, Coll. P.M. Sureshan; Allotype: ♂, Peechi, 28.x.1989, Coll. Narendran and party; Paratypes: 1♀, Peechi, 5.ii.1989, Coll. P.M. Sureshan; 2♀, Shertallai, 27.ii.1989; 1♀, data as that of holotype; 16♀, Calicut University Campus, Coll. P.M. Sureshan from 1986-89.

Remarks: This species resembles *O. ferus* (Girault) in having slender antenna with F1 length 2.5x width, F2 and F3 length 2x width, F5 equal to pedicel; forewing with PMV elongate, length 2x STV, less robust body, tegulae and general coloration yellow, but differs from *ferus* in having scape less than twice the club; propodeum without an obscure cross ridge before middle; gaster with T2 a little shorter than T3 and antenna reddish except reddish-black on scape and pedicel (in *ferus* scape length twice the club, propodeum with an obscure ridge before middle, T2 equal to T3 and T4, and antennae except scape and pedicel reddish-black).

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A NEW GENUS AND TWO NEW SPECIES OF ARCTIINAE, ARCTIIDAE: LEPIDOPTERA, FROM INDIA[1]

JAGBIR S. KIRTI AND AMRITPAL S. KALEKA[2]

(*With eighteen text-figures*)

Key words: *Juxtarctia, J. monospinuatus* sp. nov., *J. bispinuatus* sp. nov., genitalia, scales

Two new species *monospinuatus* and *bispinuatus* referable to a new genus *Juxtarctia* are reported from India. The new genus is closely related to *Spilarctia* as far as general maculation and wing pattern are concerned. However, its unique, large juxta on the male genitalia makes it different from *Spilarctia*. The shape of valva and alar expanse are some of the other important features of the new genus. Both the new species can also be separated easily on the basis of aedeagus armature.

INTRODUCTION

During the surveys undertaken for the collection of Arctiid moths from various states of northeast and northwest India, a complex phena consisting of seven representatives, was collected from Jatinga (North Cachar Hills) Assam and Nauni (Solan district) Himachal Pradesh. All these individuals possessed a similar type of maculation and wing pattern, and their tentative sorting led to the inference that they belong to two closely allied species under genus *Spilarctia* Butler. However, both of them could not be identified from the relevant literature (Hampson 1894, 1901; Arora and Choudhary 1982) or from material available in the National Museums and the Natural History Museum, London. Hence, both these species are new and closely allied with each other on the basis of maculation and genitalia. These undescribed species are also closely related to *Spilarctia multiguttata* (Walker) on the basis of ground colour and general maculation, but are clearly different with respect to different genital structures and certain other morphological features. Comparison of the genital features of these two species with those of the type species of *Spilarctia* Butler and the congenerics, *S. multiguttata* (Walker), *S. casignata* (Kollar), *S. rubilinea* (Moore), S. *erythrozona* (Kollar), *S. leopardina* (Kollar), S. *comma* (Walker), S. *niceta* (Stoll), and *S. obliqua* (Walker), reveal that the two species are unique. Nor can they be placed in the allied genera *Thanatarctia* Butler, *Spilosoma* Stephens and *Diacrisia* Hübner. The type species of these genera are clearly different and Koda (1988) has already differentiated all these genera in his paper entitled, "Generic classification of Subfamily Arctiinae of the Palaearctic and Oriental regions based on male and female genitalia". He examined the genitalia of twenty-two species of genus *Spilarctia*, along with species of *Thanatarctia*. He also erected a new genus *Cladarctia* Koda on the basis of the unique male genitalia of an Indian species.

The large and unique juxta, which is not seen in any other genus, the large alar expanse, and two pairs of semicircular signa in the corpus bursae of female genitalia distinguish the genus under consideration from the abovementioned i.e. *Spilarctia, Spilosoma, Thanatarctia, Diacrisia and Cladarctia* genera. Hence, a new genus *Juxtarctia* is proposed here to accommodate the two new species. The species *bispinuatus* is designated as the type of the new genus.

The types are deposited in the Museum of Zoological Survey of India, Kolkata (Regn. No. JS-Zoo-Mus-101).

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SYSTEMATICS

Genus *Juxtarctia* gen. nov.

Type Species: *Juxtarctia bispinuatus* sp. nov.

Distribution: Assam and Himachal Pradesh.

Diagnosis: Labial palpus long and porrect, reaching lower level of frons. Antenna bipectinate in male, serrate in female. Forewing with ground colour white, prominent black spots present; vein R_1 originating from cell; vein R_2-R_5 stalked from upper angle of cell; M_2 and M_3 closely approximated from lower angle; Cu_1 and Cu_2 arising from well before lower angle of cell. Hindwing with vein Sc+R_1 originating from before middle of cell; M_1 from upper angle; M_2 from near lower angle; Cu_1 from before lower angle of cell; Cu_2 from middle of cell. Hind tibia with two pairs of spurs.

Male genitalia with uncus of moderate size, swollen dorsally, tip curved; acrotergite well developed; fenestrula absent; tegumen longer than vinculum; vinculum short, with outer walls slightly produced; saccus small and curved; valva simple, with broad basal half and narrow cylindrical apical half; saccular margin produced into a rounded flaplike projection; sacculus and costa well defined; juxta exceptionally large and unique, broad at base, with two parallel sclerotized dilated flaps, supporting triangular bifurcated apical half; transtilla broad; aedeagus of moderate size, distinct sclerotization at distal end, bearing one or two large distinct spines; vesica armed with denticles and numerous spines.

Female genitalia with corpus bursae membranous, irregular in shape, having distinct cervix bursae; accessory sac present; two pairs of semicircular serrated signa; ductus bursae strongly sclerotized, narrow above and broad at distal end; anterior apophyses less than half the length of posterior apophyses; anterior apophyses with their apices pointed, posterior apophyses with blunt tips; papilla analis rounded and broad, fringed with an array of micro and macro setae.

KEY TO THE SPECIES OF GENUS *Juxtarctia* gen. nov.

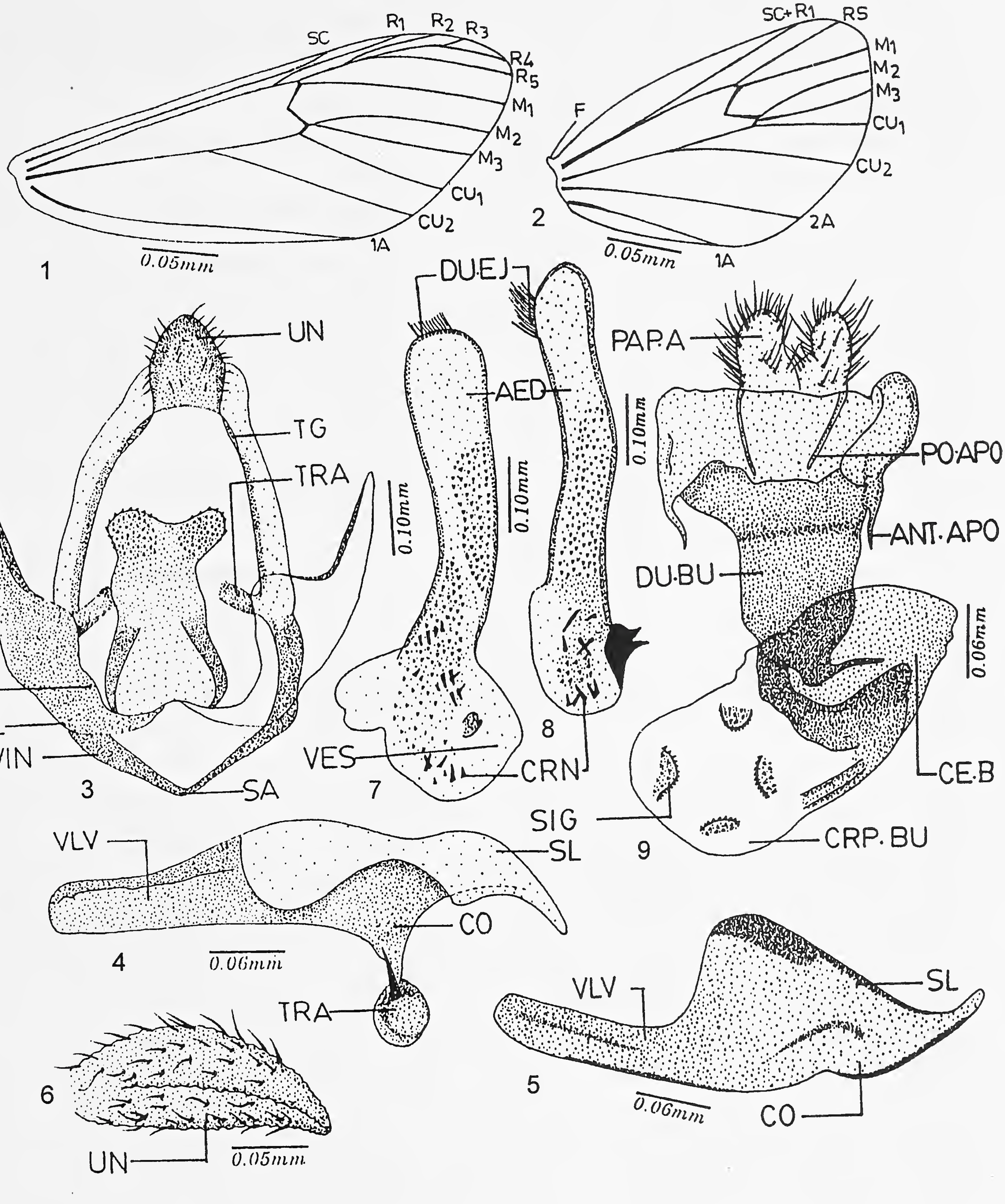
1 Forewing with veins R_2-R_5 stalked from before upper angle of cell, M_2 and M_3 minutely stalked from lower angle of cell; hindwing with vein Rs arising from before upper angle of cell; male genitalia with uncus having blunt tip; valva with apical portion of equal width, tip broad; juxta with apical margin bearing well sclerotized small setae; aedeagus with two prominent spines at distal end .... *bispinuatus* sp. nov.

— Forewing with vein R_2-R_5 stalked from upper angle, M_2 from just above lower angle, M_3 from lower angle of cell; hindwing with vein Rs from upper angle of cell; male genitalia with uncus having pointed tip; valva with apical portion gradually narrowing towards its tip; juxta with apical margin without any armature; aedeagus with a large prominent spine at distal end .... *monospinuatus* sp. nov.

Juxtarctia bispinuatus sp. nov.
(Figs 1-9)

Head with vertex and frons furnished with orange yellow scales. Antenna with scape having orange yellow scales, flagellum black. Eyes golden brown. Labial palpus long and porrect, reaching lower level of frons; first segment decorated with black scales, underside fringed with yellow; second and third segments black.

Thorax clothed with white scales; meso- and metathorax bear black spots; collar covered with orange scales and black spots; tegula white, spotted with black. Forewing with ground colour white; a basal black spot; three subbasal black spots; a streak-like spot on costa; an antemedial series of five spots, those below cell and 1A being placed outwards; a medial series of seven spots, excurved strongly at lower margin of cell; two prominent spots in cell and one beyond discocellulars; two postmedial series, first of nine spots, excurved below costa, incurved below vein



Figs 1-9: *Juxtarctia bispinuatus* sp. nov., 1. Forewing, 2. Hindwing, 3. Male genitalia, 4. Valva (left) - ventrolateral view, 5. Valva (left) - inner view, 6. Uncus - lateral view, 7. Aedeagus - dorsal view, 8. Aedeagus - ventral view, 9. Female genitalia

M_3; second again of nine spots, excurved in middle; submarginal series of paired spots on veins M_2 to Cu_1 and a black dot on Cu_2; six marginal spots present; veins R_2-R_5 stalked from before upper angle of cell; M_2 and M_3 minutely stalked from lower angle of cell. Hindwing with ground colour orange yellow; in male, two antemedial black spots, one on costa and another in cell; in female, an antemedial series of spots on either side of upper and lower margin of cell and vein 2a, becoming larger towards costa; two postmedial spots, one on costa and another below $Sc+R_1$; discoidal spots one on inner side and another beyond discocellulars; submarginal series of paired spots on veins Rs, M_2, Cu_2 and 2A; five marginal spots; fringe orange; vein Rs originating from before upper angle of cell; M_2 from above lower angle of cell; Cu_1 from before lower angle of cell. Legs with coxae clothed with yellow scales, fore coxae with large black patches; femora furnished black above, pale yellow below; tibia and tarsi dressed with yellow scales, streaked with black; outer tibial spurs almost half length of inner spurs.

Abdomen decorated with orange yellow scales; short segmental bands on dorsal side except on first two segments; last segment with a prominent black spot; lateral and submarginal series of black spots. Male genitalia with uncus short, broad, strongly swollen dorsally, setosed, tip slightly curved, blunt; tegumen broad and sclerotized, almost double the length of vinculum; vinculum broad towards tegumen, narrow towards saccus; saccus small, V-shaped. Valva broad, sacculus distinct, narrow at basal end, constricted in middle with flap-like projections; costa well defined, cucullus and valvula fused into a rounded cylindrical distal half; juxta large and unique with lateral flaps broad, triangular projection slightly notched, with layers of well sclerotized setae; transtilla rounded, oval, semisclerotized.

Aedeagus long, slightly curved in middle, both of its walls equally sclerotized, with a distinct sclerotization at distal end, bearing two distinct, but unequal, blunt spines; vesica armed with large number of denticles and distinct pointed cornuti.

Female genitalia as described in diagnosis of the genus.

Wing Expanse (Half): Male 25 mm; Female 25 mm.

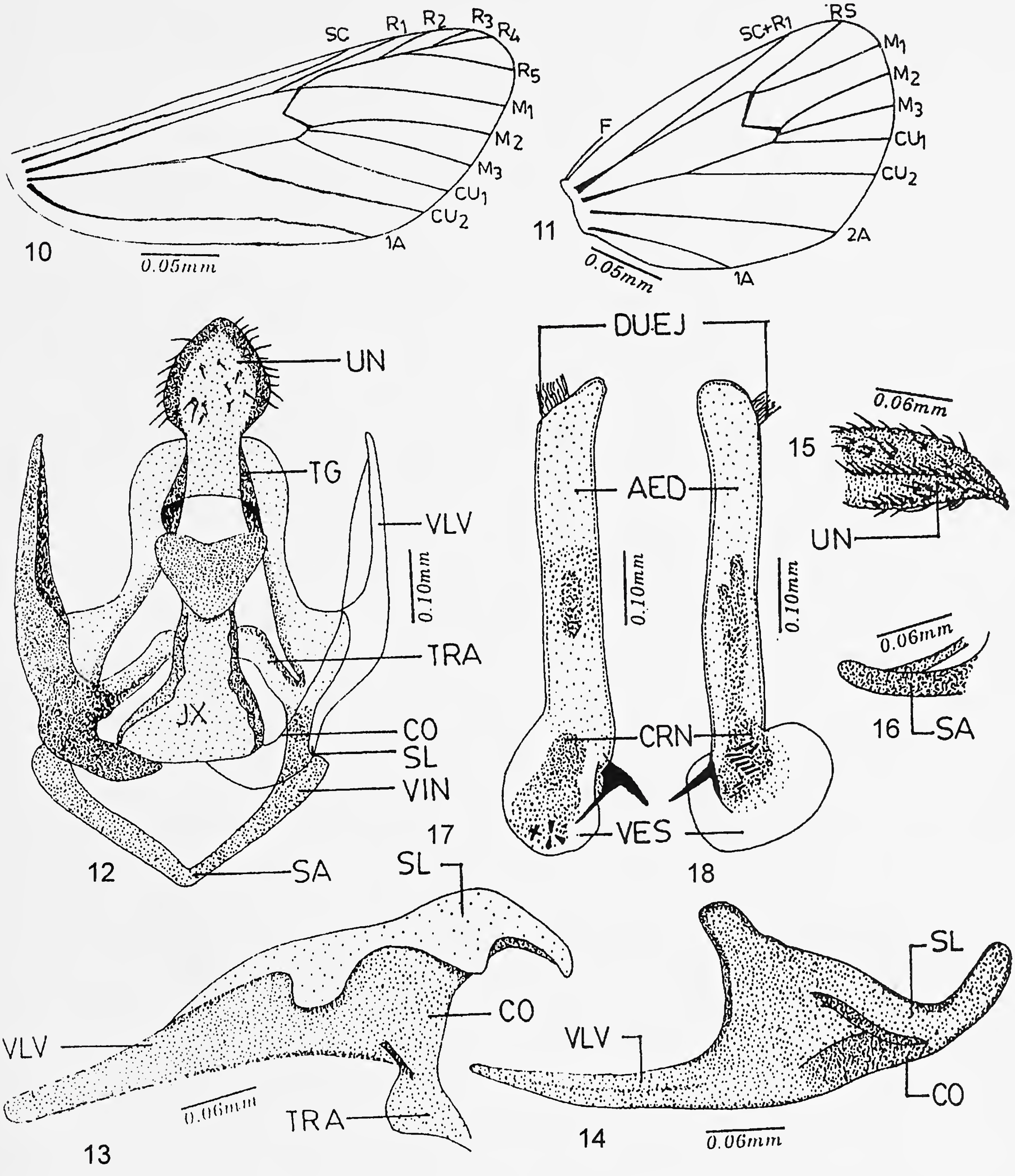
Material Examined: Holotype: INDIA: Assam: North Cachar Hills, Jatinga, 900 m, 1.x.1995, one male. Coll. A.P. Singh. Paratypes: INDIA: Assam: North Cachar Hills, Jatinga, 900 m, 1.x.1995, one male, Himachal Pradesh: Nauni, 900 m, 2.viii.1994, one female, Coll. A.P. Singh.

Etymology: The name of the species pertains to the armature of aedeagus.

Juxtarctia monospinuatus sp. nov.
(Figs 10-18)

Head with vertex and frons covered with orange yellow scales. Antenna with scape studded with orange scales, flagellum black. Eyes golden brown with black spots. Labial palpus porrect, reaching lower level of frons, first and second segments decorated with black scales, underside fringed with yellow; third segment black.

Thorax covered with white scales; meso and metathorax with black spots; collar orange, spotted with black; tegula covered with white scales and black spots. Forewing with ground colour white; a basal black spot; three subbasal black spots; an antemedial series of five spots, spots below cell and 1A placed outwards; a medial series of seven spots, strongly angled outwards on lower margin of cell; spots in each angle and one beyond discocellulars; two postmedial series of nine spots each, first one bent outwards from costa, then inwardly oblique below median nervure, second excurved in middle, incurved below Cu_1; submarginal series of spots on each side of veins R_4-Cu_1, those on M_2 placed outwards; a marginal series of six spots; fringe white; underside orange yellow



Figs 10-18: *Juxtarctia monospinuatus* sp. nov., 10. Forewing, 11. Hindwing, 12. Male genitalia, 13. Valva (left) - ventrolateral view, 14. Valva (left) - inner view, 15. Uncus - lateral view, 16. Saccus - lateral view, 17. Aedeagus - dorsal view, 18. Aedeagus - ventral view

except at apical area, spots larger and diffused; veins R_2-R_5 stalked from upper angle of cell; M_2 arising from just above lower angle of cell. Hindwing with ground colour orange yellow; two antemedial spots on costa and cell; two black spots present inside discocellulars and another one outside of discocellulars; submarginal spots on each side of R_5, M_2, Cu_2 and 2A; marginal spots on either side of M_1, M_2, M_3 and Cu_2, spots diffused on underside and conjoined; veins Rs and M_1 originating from upper angle of cell; M_2 from above lower angle of cell; Cu_1 well before lower angle of cell. Legs with coxae covered with yellow scales, fore coxae with large black patches; femora black above, pale yellow ventrally; tibia and tarsi decorated with yellow scales, streaked with black; outer tibial spurs half the length of inner ones.

Abdomen clothed with orange yellow scales; short segmental bands on dorsal side, except on first two segments; a large rounded spot present on last segment; lateral and sublateral series of black spots; underside with black bands on seventh, eighth and ninth segments.

Male genitalia with uncus short, broad, strongly swollen on dorsal side, setosed, tip slightly curved and sharply pointed; tegumen broad, much longer than vinculum; vinculum short, broad, sclerotized, with outer walls slightly produced; saccus small, V-shaped. Valva simple, divided into two halves, broad at base, narrow and cylindrical above; sacculus distinct, costa defined; saccular margin produced into a rounded flaplike projection; cucullus and valvula fused; juxta exceptionally large and unique, broad at base, with two parallel sclerotized dilated flaps, narrow at both ends, supporting triangular bifurcated, well developed structure above these flaps; transtilla broad, semisclerotized.

Aedeagus long, tip rounded, both of its walls equally sclerotized, a distinct sclerotization at distal end, bearing a large distinct spine; vesica armed with denticles and large number of spines.

Female genitalia not examined.

Wing Expanse (Half): Male 24 mm.

Material Examined: Holotype: INDIA: Assam: North Cachar Hills, Jatinga, 900 m, 29.ix.1995, one male, Coll. A.P. Singh. Paratypes: INDIA: Assam, North Cachar Hills, Jatinga, 900 m., 11.ix.1991, one male; 25.ix.1995, one male; 1.x.1995, one male, Coll. A.P. Singh.

Remarks: The new species *monospinuatus* is closely allied to *bispinuatus* sp. nov. on the basis of general ground colour, ornamentation of wings, labial palpus and abdomen. It is distinct from *bispinuatus* with respect to uncus having a pointed tip, valva with prominent saccular finger-like projection and an altogether different juxta. Aedeagus of this species is also distinct from the type species.

Etymology: The species has been named after the single prominent spine in the vesica of aedeagus.

Abbreviations: 1A: First anal vein, 2A: Second anal vein, AED: Aedeagus, ANT.APO: Anterior apophyses, CE.B: Cervix Bursae, CO: Costa, CRN: Cornuti, CRP.BU: Corpus Bursae, Cu_1: First Cubital Vein, Cu_2: Second Cubital Vein, DU.BU: Ductus bursae, DU.EJ: Ductus ejaculatorius, F: Frenulum, JX: Juxta, M_1: First median vein, M_2: Second median vein, M_3: Third median vein, PAP.A: Papilla analis, PO.APO: Posterior apophyses, R_1: First radial vein, R_2: Second radial vein, R_3: Third radial vein, R_4: Fourth radial vein, R_5: Fifth radial vein, Rs: Radial sector, SA: Saccus, Sc: Subcosta, $Sc+R_1$: Stalk of $Sc+R_1$, SIG Signum, SL: Sacculus, TG: Tegumen, TRA: Transtilla, UN: Uncus, VES: Vesica, VIN: Vinculum, VLV: Valva.

ACKNOWLEDGEMENT

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A NEW BARILINE CYPRINID FISH OF THE GENUS *BARILIUS* HAMILTON, FROM MANIPUR, INDIA[1]

WAIKHOM VISHWANATH AND WAHENGBAM MANOJKUMAR[2]

(*With two text-figures*)

Key words: Bariline cyprinid fish, *Barilius ngawa* sp. nov., Manipur

Barilius ngawa, a new species is described from the Manipur river, Manipur, India. The fish is characterised by an elongated body, moderate body depth (22.5-26.9% of standard length), 42-43 perforated scales along the lateral line, 21-22 scales on the mid-dorsal streak in front of dorsal fin insertion and 16-17 circumpeduncular scales, 13-14 vertical dark bars on sides, and diameter of eyes 21.3-25.8 of length of head length. The species is distinct from the Burmese forms *B. barnoides* Vinciguerra and *B. ornatus* Sauvage in having more lateral line scales, shallower body and smaller eyes.

INTRODUCTION

Species of *Barilius* Hamilton (1822) are compressed, their scales are marked with incomplete transverse bars or spots, dorsal fins are inserted beyond the middle of the fish. The systematic position of the genus has been studied in detail by Howes (1980) based on detailed anatomical and osteological characters. The taxon now inhabits the Indian subcontinent, Thailand, Myanmar, South China (Yunnan), Cambodia, Laos, Vietnam and Borneo. The genus is characterised by having a deep rostrally curved ethmoid region, elongated nasals and parietals and reduced lateral ethmoids. The Indo-Burmese species, namely *Barilius bola* (Hamilton) and *B. guttatus* Day have been placed in the genus *Raiamas* Jordan on the basis of their features such as a greatly expanded kinethmoid, long shallow jaws and reduced premaxillary ascending process (Howes 1980).

Three species of *Barilius* were hitherto known from Manipur, India. They are *B. barila* (Hamilton), *B. bendelisis* (Hamilton) and *B. dogarsinghi* Hora. Of these, the first two are widely distributed both in the Ganga-Brahmaputra system; and the last, only in the streams of Manipur, leading to the Chindwin drainage of Myanmar. While making collections in the Manipur River System leading to the Chindwin, a new *Barilius* was discovered and is described below.

MATERIAL AND METHODS

Fishes were collected by gill net and preserved in 10% formalin. Photographs were taken before preservation. Details of the collection and coloration were noted. Counts and measurements follow Jayaram (1981). Dial calipers were used for measurement up to 0.1 mm accuracy. The specimens were deposited in the Manipur University Fish Museum (MUFM). Abbreviations: SL = standard length, and HL = head length.

Barilius ngawa sp. nov. (Fig. 1)

Holotype: MUFM 149, 84.8 mm, Sherou river, (tributary of Manipur river), 24° 18' N, 93° 54' E, 83 km south of Imphal, Manipur, W. Manojkumar, 20.iii.1993.

Paratype: MUFM 150, 40 exs., 61.5-134.3 mm, same data as holotype.

Diagnosis: An elongated *Barilius* of moderate body depth, its depth 22.5-26.9% of

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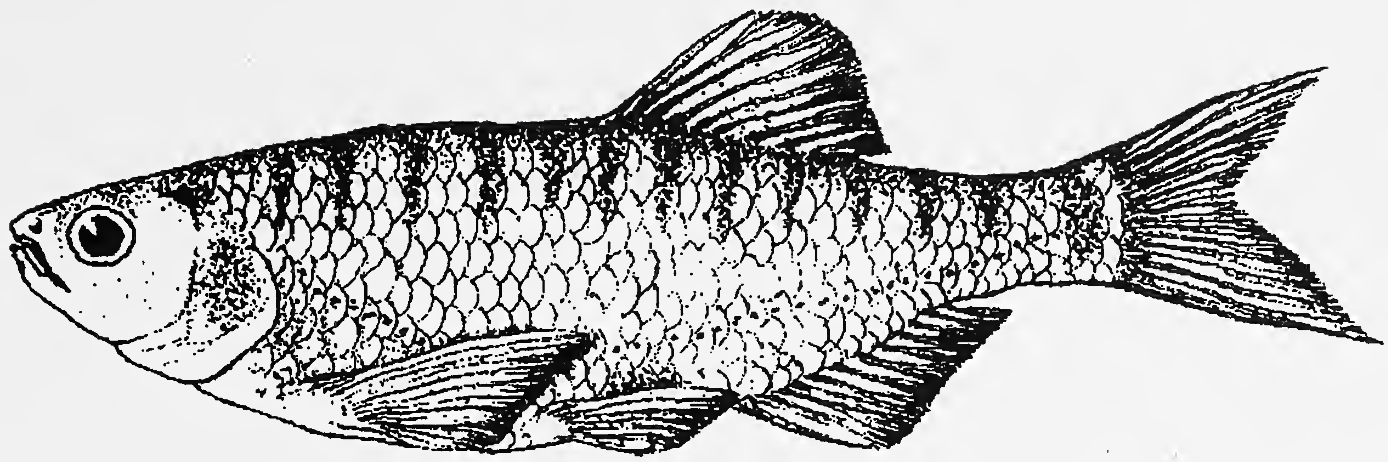

Fig. 1: Paratype of *Barilius ngawa* (MUMF 150/1), 124 mm SL

SL. 42-43 perforated scales along the lateral line. 21-22 scales on mid-dorsal streak in front of dorsal fin insertion and 16-17 circumpeduncular scales. Vertical bars on sides 13-14; eye diameter 21.3-25.8 of HL.

Description: D. ii-iii, 7-8; P. i, 12-13; V. i, 7, 1; A. ii-iii, 10-11; C. 19 (10+9); L.1. 42-43; L. tr. 8/1/2; PDS. 21-22. Body compressed, snout pointed, mouth terminal, gape of mouth reaching the middle of orbit, eyes large, but smaller than other related species (Table 1). Barbels 2 pairs. Snout long, its length equals interorbital space. Dorsal fin inserted opposite interspace between pelvic and anal fin base. Lower jaw with a symphysis and upper jaw with a notch to receive the knob. Depth of body equals length of head. Pelvic fin short. Caudal fin deeply forked, the lobes are equal, muscular pads are present at the base of pectoral and pelvic fins.

Proportional measurements of holotype and paratype (range in parentheses) in percentage of SL are given in Table 1.

Coloration: In life, sides are silvery, dorsal golden yellow, darkest at the mid-dorsal line. Sides with 13-14 vertical blue-black bars extending to the lateral line region of the body. Dorsal fin with a dark band. Caudal with dark margins. Fins with orange coloration in the margin.

Etymology: The local name is Nga-wa (Nga = fish; wa = swift movement of shoal). The species is named after its local name.

Habitat: The Manipur river follows a southward course, receiving several hill streams, and flows out of the State into Myanmar after receiving a tributary called Yankoilok. It then flows in the Chin Hills and then finally joins the Chindwin. The river has clear water with rocks and pebbles at the substratum. Sherou, the

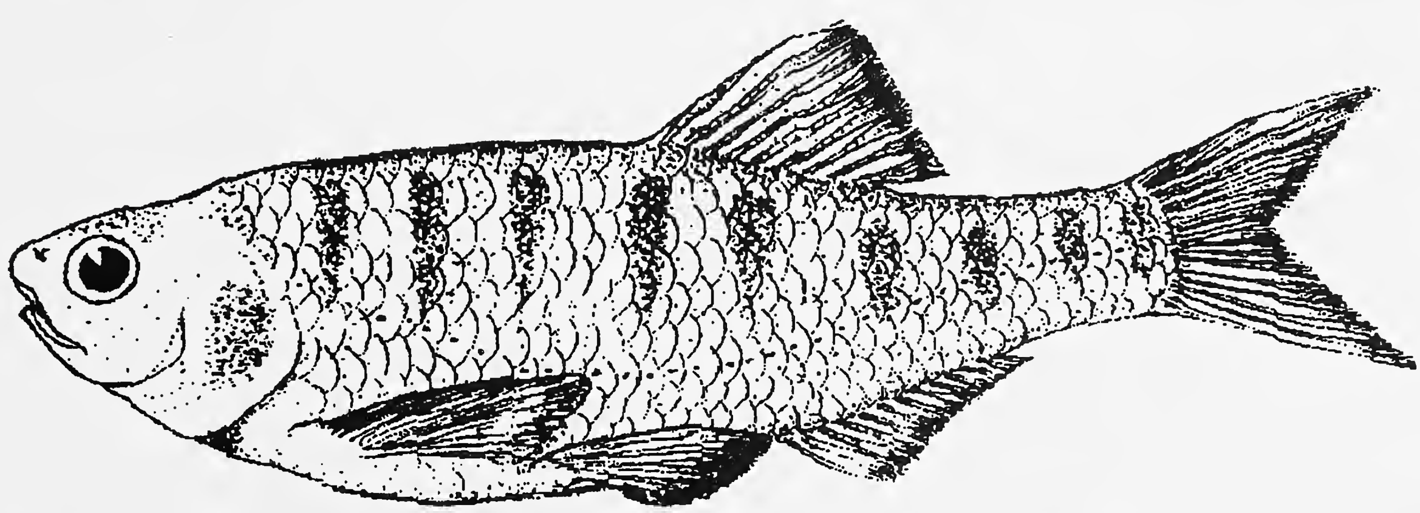

Fig. 2: *Barilius barnoides* (CMK 4280), collected by P. Hobleman from Mae Son Province, Thailand

TABLE 1
COMPARISON OF MORPHOMETRIC CHARACTERS OF *BARILIUS NGAWA* SP. NOV.
WITH THOSE OF *B. BARNOIDES* VINCIGUERRA AND *B. ORNATUS* SAUVAGE

	Barilius ngawa sp. nov.		*Barilius barnoides*	*Barilius ornatus*	
	Holotype	Paratype (range)	CMK 4053 & 4280	After Kottelat (1984)	ZSI 6/ 2986-87
N	1	40	2	2	2
SL (mm)	84.8	35.0-134.3	61.2-83.3	90.0-92.0	67.0-89.2
In % of SIL					
Body depth of dorsal origin	24.1	22.5-26.9	27.5-29.8	33.6-35.6	31.1-31.3
Body depth at pelvic origin	25.8	23.7-29.3	29.6-32.4	-	-
Head length	24.8	24.7-26.9	26.1-26.4	27.8-28.3	26.9-29.4
Predorsal length	56.3	55.1-57.8	57.3-57.7	59.8-64.4	52.2-58.9
Length of caudal fin	25.5	24.0-28.6	29.9-30.7	-	-
Height of dorsal fin	17.8	17.7-19.9	20.8-24.0	-	24.0-24.6
Length of dorsal fin base	11.7	11.1-13.7	14.4-15.0	-	12.5-14.7
Length of pectoral fin	19.1	19.4-21.1	21.9-23.6	-	22.4-24.0
Length of pelvic fin	12.5	12.3-14.3	15.0-16.2	-	16.4-16.5
Length of anal fin	13.8	13.8-16.4	16.8-17.3	-	21.7-22.4
Length of anal fin base	14.9	14.0-17.6	16.3-18.3	-	14.5-14.7
Prepelvic length	47.8	47.8-51.6	49.3-52.5	56.5-58.9	-
Preanal length	68.0	66.0-69.9	68.8-70.8	75.0-78.9	-
Pre-anus length	65.0	63.2-66.7	60.0-66.8	72.8-77.8	-
In % of head length					
Height of head at occiput	69.5	63.0-76.6	78.06-79.4	-	73.9-82.0
Length of snout	31.0	29.7-31.2	29.5-33.8	26.9-28.0	32.0-36.2
Diameter of eyes	24.8	21.3-25.8	27.3-29.4	-	27.8-31.6
Interorbital space	33.3	29.1-34.4	33.7-36.3	38.8-32.0	32.8-33.3
Length of caudal peduncle	73.8	69.3-79.0	58.2-65.0	56.0-61.5	45.9-61.1
Height of caudal peduncle	40.0	37.4-43.4	42.5-46.4	42.3-44.0	41.0-44.28
Width of head	44.8	38.0-45.9	43.2-45.0	-	34.8-44.4
In % of length of caudal peduncle					
Height of caudal peduncle	54.2	54.2-66.7	65.4-79.7	68.8-78.6	70.0-89.3
In % of distance between pelvic and anal fins					
Vent to anal origin	9.6	5.3-11.3	8.9-9.8	-	-
In % of distance between pelvic and caudal fins					
Vent to pelvic fin origin	35.5	33.9-38.3	33.6-34.8	-	-
COUNTS					
D rays	iii, 7	ii-iii, 7-8	ii, 8	iii, 7-8	iii, 8
P rays	i, 12	I, 12-13	i, 12	14-15	i, 13-14
V rays	i, 8	i, 8	i, 8	9-10	i, 8
A rays	ii, 11	ii-iii, 10-11	ii, 11	iii, 10-11	iii, 10-11
C rays	10+9	10+9	10+9	9+8	19
L.1 (Lateral line longitudinal scales)	42	42-43	40	41	38-40
L. tr. (Lateral transverse scales)	8/1/2	8/1/2	7/1/2-3	H7/1/2h	7/1/2
Predorsal scales	21	21-22	17-18	14-16	19-20
Circumpeduncular scales	16	16-17	14	12	-
Transverse bands	13	13-14	9-10	-	-

type locality has an elevation of about 750 m above msl and water temperature ranges between 8-25 °C, whereas the elevation of Yangkoilok is about 100 m above msl and water temperature is 8-28 °C. The river is mostly shallow (1.5-2.0 m deep), but there are rocky pools where the depth exceeds 3.5 m. The river has a luxuriant growth of shrubs, trees and bamboos on both banks, and paddy fields wherever there is human habitation.

Discussion: *Barilius ngawa* is close to *B. barnoides* Vinciguerra (Fig. 2) in its predorsal length, counts of dorsal, pectoral, ventral and anal fins, but differs in having smaller number of caudal fin rays, greater number of lateral line scale rows, fewer lateral transverse scales, greater number of predorsal scales. It also has a shallower body and smaller diameter of eyes. *B. ngawa* is also distinct from the upper Burma form (Shan State), i.e. *B. ornatus* Sauvage in having greater number of lateral line scales and circumpeduncular scales, shallower body, shorter head and predorsal length, smaller eye diameter, greater snout length and lesser height of caudal peduncle. A comparative account of the meristic characters and proportional measurements is given in Table 1. The new species also differs from *Barilius dogarsinghi* Hora in having greater numbers of transverse bars on the body (13-14 vs. 8-9) and more prominent symphyseal knob on the lower jaw. Kottelat (1984) mentioned that the description of *Danio monshiensis* Wu *et al.* agreed with that of *Barilius barnoides* except for the length of the caudal peduncle. However, *Danio monshiensis* of Yunnan, China (as per description by Wu *et al.* 1964), differs from *B. barnoides* in having 15-17 transverse bars on the body (although the drawing No. 1-44 of the paper shows only 13 bars) vs. 9-10 bars and lateral line scales 42-44 vs. 40-41. The new species is also distinguished from *monshiensis* in having a greater number of predorsal scales (21-22 vs.18-19), circumpeduncular scales (16-17 vs. 14-15) and equal caudal fin lobes vs. unequal caudal fin lobes with the lower lobe conspicuously longer. Talwar and Jhingran (1991) considered *B. ornatus* Sauvage as a synonym of *B. barnoides* Vinciguerra, by confining the distribution of the latter to Myanmar. But *B. ornatus* described by Kottelat (1984), differs from *B. ornatus* examined by us in predorsal scale and circumpeduncular scale counts (Table 1).

Comparative materials. *Barilius ornatus*, ZSI 2986-87, 2 exs., Nampamdet, Shan States, *Barilius barnoides* (CMK 4053, 4280, 2exs., Mae Hong Son Province, Thailand. CMK = Collections of Maurice Kottelat, Switzerland)

Acknowledgments

We thank the Director, Zoological Survey of India, Kolkata, for permitting us to examine types of *Barilius ornatus* in the National Museum, Kolkata, and Dr. Maurice Kottelat, Switzerland for the loan of *Barilius barnoides* collected from Thailand.

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TWO NEW SPECIES OF SCHIZOMIDS FROM INDIA WITH RANGE EXTENSION FOR *SCHIZOMUS TIKADERI* (ARACHNIDA: SCHIZOMIDA)[1]

D.B. Bastawade[2]

(*With twenty-six text-figures*)

Key words: Arachnida, Schizomida, *Schizomus chalakudicus* sp. nov., *S. chaibassicus* sp. nov., *S. tikaderi,* new description, range extension

Schizomid collections deposited by F.H. Gravely in the erstwhile Indian Museum, Calcutta (= Kolkata) were located and studied. The specimens collected from Chaibassa, Chhota Nagpur, Bihar and Chalakudi near Cochin, Kerala are new species and have been described and illustrated. The specimens for *Schizomus tikaderi* were collected from localities other than the type locality and have been added as new known localities and range extension for this species in Western India.

The schizomids, tiny animals which inhabit specialized habitats, occupy a distinct order amongst the Arachnids. They have received little attention from arachnologists, and need thorough exploration. Pocock (1900) has reported four species under the Suborder Tartarides in the FAUNA OF BRITISH INDIA. Subsequently, Gravely (1911a, 1911b, 1912, 1915, 1925) collected schizomids from India, Sri Lanka and Burma, and described three new species from India (Bastawade 1985, Bastawade and Pal 1992, Cockendolpher 1981, Cockendolpher *et al.* 1994 and Reddell and Cockendolpher 1985, 1991). Fernando (1957) described a new species from Sri Lanka. Cockendolpher, Sissom and Bastawade (1988) have described a new species *Schizomus tikaderi* from Maharashtra, India.

The type specimens of the three new species described by Gravely were deposited in the collections of the erstwhile Indian Museum, Calcutta (presently called the National Collections, Zoological Survey of India, Kolkata). He also deposited some undescribed schizomid collections, which have been studied by the author, and two new species *Schizomus chalakudicus* sp. nov. and *S. chaibassicus* sp. nov., from Kerala and Bihar states respectively, described here. Two new records of *Schizomus tikaderi* from the Western Ghats, Maharashtra, have also been given.

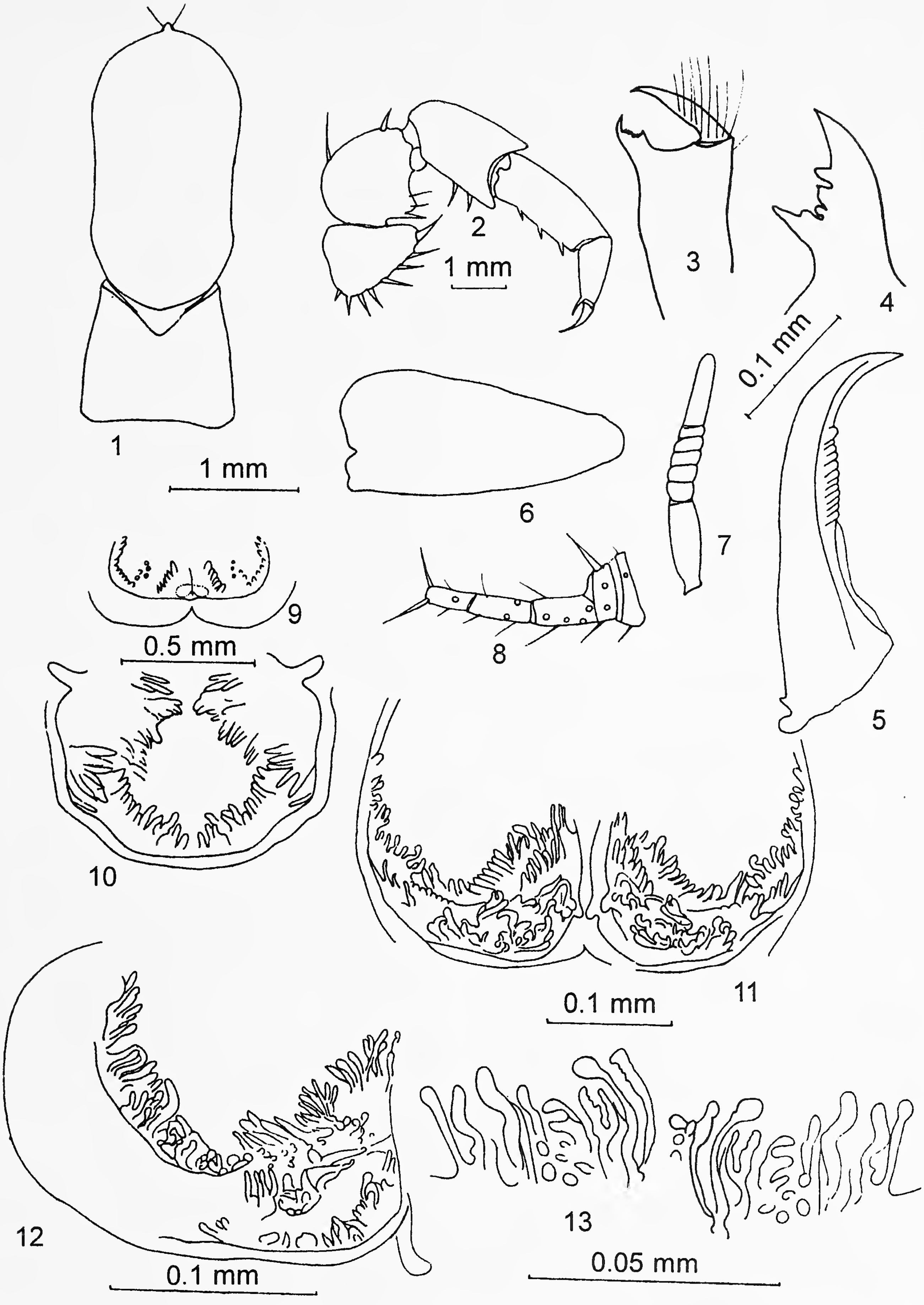
[1]Accepted August, 1999

[2]Zoological Survey of India, Western Regional Station, Vidyanagar, Sector 29, Opp. Akurdi Railway Station, Rawet Road, Akurdi, Pune 411 044, Maharashtra, India.

Schizomus chalakudicus sp. nov.
(Figs 1-13)

Female, cephalothorax smooth, propeltidium acutely pointed on mid anterior margin, bent down at the forward end and supported with a median seta and a pair of basal setae, three pairs of dorsal submedian setae present, eyes or eyespots totally absent, mesopeltidium very thin and separated medially, metapeltidium deeply notched on anterior middle portion, no setae clearly noticed. Sternal setae not clear, but a pair of long sternapophysial setae present on anterior margin of anterior sternum.

Abdomen with tergites and sternites smooth, setation not clear, except for a pair of dorsal median setae on tergites I-IV; tergites X-XIII telescoped, with no clearly identifiable setae, segment XII without posterior process but armed with a pair of spinose setae, other setae unclear. Flagellum three segmented, only one pair of lateral and dorsal setae clearly present on the last annulus (Fig. 8). Sternite I: 0.86 times as wide. Spermathecae tubuliform, with numerous irregular shaped tubes on each side (Figs 9-13).



Figs 1-13 *Schizomus chalakudicus* sp. nov., 1. Dorsal view of Cephalothorax, 2. Lateral view of Pedipalp, 3. Lateral view of Chelicera, 4. Lateral view of immovable finger of Chelicera, 5. Lateral view of inner margin of movable finger of Chelicera showing serrula, 6. Lateral view of Femur IV, 7. Lateral view of tarsus of leg I, 8. Lateral aspect of Flagellum, 9-12. Ventral view of Spermathecae and gonopods, 13. Details of tubuliform spermathecae

Chelicera with basal segment twice as wide, types of setae present as 1=3, 2=4,3=6-7, 4=2, 5=?, and 6=1; immovable finger with three sharp teeth between two large teeth (Fig. 4), movable finger smooth except a rounded tooth at distal end of 11-12 sutured serrula on inner margin (Fig. 5).

Pedipalp with almost triangular form of trochanter, with 5-6 spinose setae on exterior ventral margin, femur round with an inner knob (Fig. 2), mesal surface with 5 spinose setae clearly noticed on ventromesal surface, all carinae obsolete; patella smooth, no spur on ventrolateral surface but only a few plumose setae seen; tibia also smooth, carinated, 4 spinose setae on ventromesal margin, carinae obsolete. Basitarsus-tarsus smooth, claw as long as basitarsus, spur about 1/3.

Legs I-IV as in Table 1, Femur IV 2.25 times as wide (Fig. 6).

Measurements (in mm): Total length 5.59; Cephalothorax 1.72 (Propeltidium 1.2 & Mesopeltidium 0.51), Abdomen 3.07 and Flagellum 0.77.

Material examined: Holotype 1♀ (in spirit) deposited in the National Zoological Collections of the Zoological Survey of India, Kolkata, Regn. No. not stated, Coll. F.H. Gravely, 14-30.ix.1914, type locality Chalakudi near Cochin (previously Cochin state), Kerala, India.

Distribution: Known only from the type locality.

Etymology: The new species has been named after the type locality Chalakudi.

Schizomus chaibassicus sp. nov.
(Figs 14-26)

Female of 6.106 mm body size (except flagellum), pale yellowish-brown, paler on digits, body surface smooth, flagellum of three annulli.

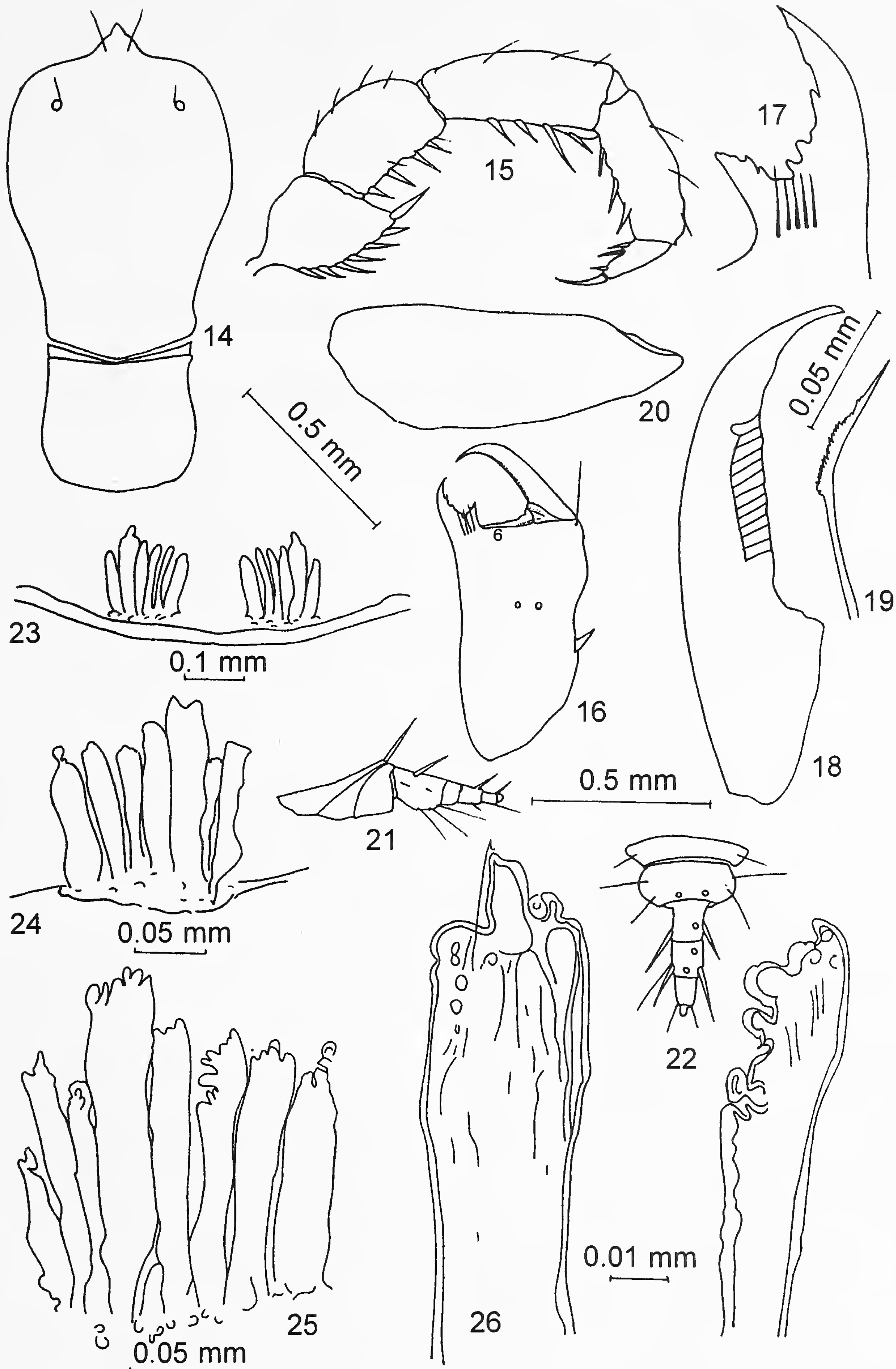
Cephalothorax with smooth propeltidium, pointed medially on anterior margin, slightly bent forward, supported with a pair of basal setae, one pair of dorsal setae situated posteriorly at 1.05 mm, a pair of inconspicuous lateral eyespots present, mesopeltidium narrow, separated medially by almost half of its length, metapeltidium undivided, at the most notched medially on anterior margin (Fig. 14).

Abdomen with all tergites and sternites smooth, tergites I-IX each provided with a pair of median and a pair of lateral setae, tergites X-XI telescoped with 2-3 pairs of dorsal setae, sternite I 0.86 mm long and 1.03 mm wide, setation unclear; segment XII with two dorsal spinose setae and two pairs of ventral setae, without a dorsal process. Flagellum of three annulli, 0.645 mm long, setation as in Figs 21 & 22. Spermathecae elongated, lobate and form a cluster of 8-9 lobes as in Figs 23-26.

Chelicera 1.62 mm long, basal segment almost twice as wide, with a forwardly bent spinulated spine present on dorsal sub-basal portion, fixed finger with only two teeth

TABLE 1
MEASUREMENTS IN MM FOR THE PEDIPALP AND LEGS I-IV OF *SCHIZOMUS CHALAKUDICUS* SP. NOV.

	Trochanter	Femur	Patella	Tibia	Basitarsus	Tarsus	Total
Pedipalp	0.602	0.645	0.688	0.645	0.612		3.10
Legs I	0.452	1.333	1.591	1.505	0.473	0.903	6.257
II	—	0.860	0.516	0.666	0.516	0.430	—
III	0.344	0.946	0.473	0.430	0.559	0.566	3.268
IV	0.430	1.548	0.688	0.989	0.774	0.686	5.117



Figs 14-26 *Schizomus chaibassicus* sp. nov., 14. Dorsal view of Cephalothorax, 15. Lateral view of Pedipalp, 16. Lateral view of Chelicera, 17. Lateral view of immovable finger of Chelicera, 18. Lateral view of inner margin of movable finger of Chelicera showing serrula, 19. Enlarged view of 'blood hair' of Type I on immovable digit of Chelicera, 20. Outer (lateral) view of Femur IV, 21. Lateral view of Flagellum, 22. Dorsal view of Flagellum, 23-25. Ventral view of Spermathecae and gonopods, 26. Details of tubuliform spermathecae

TABLE 2
MEASUREMENTS (MM) OF PEDIPALP AND LEGS I-IV OF *SCHIZOMUS CHAIBASSICUS* SP. NOV.

	Trochanter	Femur	Patella	Tibia	Basitarsus	Tarsus	Total
Pedipalp	0.903	0.860	0.903	0.731	0.301		3.698
Legs I	0.559	1.935	1.849	1.548	0.473	0.817	7.181
II	0.301	1.505	0.645	0.817	0.688	0.473	4.429
III	0.387	1.118	0.516	0.645	0.731	0.645	4.042
IV	0.430	1.763	0.817	1.247	1.032	0.774	6.063

(Fig. 17), 13-14 minutely sutured serrula on inner margin without guard teeth, types of setae present as 1=4, 2=4, 3=5, 4=2, 5=7 and 6=1.

Pedipalp with trochanter acutely produced anteriorly, ventromesal margin with 7 stout spinose setae (Fig. 15), femur not rounded, smooth, without carinae, anteroventral margin with 3 spinose setae, mesal with 1 seta; patella acarinated, smooth, ventrolateral margin with 3 spinose setae, one much longer, dorsal surface with 2 to 4 long setae; tibia with scattered delicate setae, dorsal surface with few plumose and 3 spinose setae; basitarsus-tarsus with several long plumose setae on ventromesal and ventral surface, claw about 2/3 of basitarsus-tarsus, spur about 1/3, anterior sternum with 7-8 setae and a pair of long stenapophysial setae, posterior sternum with 10 setae. Legs I-IV as in Table 2, Femur IV 2.8 times as wide as long (Fig. 20).

Measurements (in mm): Total length 6.106, Carapace 2.236 (Propeltidium 1.806, mesopeltidium, metapeltidium 0.43); Abdomen 3.87, Flagellum 0.645.

Material examined: Holotype 1♀ (in spirit) deposited in the National Zoological Collections of the Zoological Survey of India, Kolkata; Regn. No. not stated, Coll. P.E. Gravely, 1.x.1919, Type locality a pass between Chaibass and Chakradharpur, Chota Nagpur, Bihar, India.

Distribution: Known only from the type locality.

Etymology: The species name is derived from the type locality Chaibass.

Schizomus tikaderi
Cockendolpher, Sissom and Bastawade

This interesting species of Schizomida is so far known only from Sinhagad, Dist. Pune (Holotype) and from Bhiv Ghat, Dist. Sangli, Maharashtra (Paratype) (Cockendolpher *et al*, 1988). During recent surveys of the Western Ghats, the author could collect 2 ♀♀ from Phonda Ghat (800 m above msl) and 2 ♀♀, 1 ♂ immature from Amboli Ghat (650 m above msl) both in Sindhudurg district, Maharashtra, thus extending its distributional range southwards in western peninsular India.

ACKNOWLEDGEMENTS

I sincerely thank the Director, Addnl Directors, Jt Directors and Dy Directors of the Zoological Survey of India, Kolkata, Freshwater Biological Station, Hyderabad and Western Regional Station, Pune, and all officers and staff of ZSI, Kolkata and different Regional Stations for providing financial grants, permitting to study old material and generous help during the studies. I thank Mr. and Mrs. Cockendolpher and Mr. Reddel, Texas, USA for valuable literature and guidance. I also thank Mr. P.W. Garde, ZSI, WRS, Pune for artworks.

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■ ■ ■

A NEW SPECIES OF *DESMODIUM* DESVAUX., FABACEAE, FROM GARHWAL HIMALAYA, UTTARANCHAL, INDIA[1]

L.R. Dangwal and R.D. Gaur[2]

(*With one text-figure*)

Key words: *Desmodium garhwalensis* sp. nov., *D. elegans* DC., Fabaceae, Nauti, Chamoli District, trekking route, Garhwal Himalaya, Uttaranchal

During the field survey and plant explorations in the remote localities of the Garhwal Himalaya (NW Himalaya) the authors collected some interesting specimens of the genus *Desmodium* Desvaux (Fabaceae) from Nauti (Chamoli District), Uttaranchal, from the scrub jungles along trekking routes. Thorough study of the literature and comparison of the specimens of the regional Herbaria housed at the Botanical Survey of India, Northern Circle (BSD) and Forest Research Institute (DD), Dehra Dun, indicate distinct differences between *D. garhwalensis* sp. nov. and *D. elegans* DC.

In the course of survey and plant collection in the remote localities of the Garhwal Himalaya (NW Himalaya), the authors came across some interesting specimens of the genus *Desmodium* Desvaux. These were collected from Nauti above Karnaprayag (Chamoli district), from the scrub jungle along trekking routes. Scrutiny of the literature as well as comparison of the specimens with those of the Herbaria Botanical Survey of India, Northern Circle (BSD), and Forest Research Institute (DD), Dehra Dun, indicated distinct features, suggesting a new species, closely allied to *Desmodium elegans* DC.

Desmodium garhwalensis sp. nov.
Dangwal et Gaur

Desmodium eleganti DC. proxime affine, differt caule glabrescenti dilute brunneo, ramulisque vix piloso; foliis 3.0-7.0 cm longis (petiolo incluso); foliolis terminalibus *c.* 5.0 x 3.0 cm, supra atro-viridis, tegetes formantes pilis sericeis albis, infra dilute viridis, parum pilosis in nervis; petiolo 1.5-2.0 cm longo; petiolulo 0.5-1.0 cm longo; inflorescentia 5.0-12.0 cm longa; floribus *c.* 2.0-6.0 mm longis; bracteis linearibus, 1.0-2.0 mm longis; leguminibus stipitatis, *c.* 1.0-2.0 x 0.1-0.2 cm, sericeis brunneis, 2-8 articulatis, leguminis articulo constricto (1.0 mm lato); segmentis simplicibus, *c.* 2.0 mm longis, seminibus dilute luteis ad atro-luteis, *c.* 2.0 x 1.0 mm.

Frutices decidui dilute brunnei glabrescentes, usque ad 2.0 m longi; rami vix pilosi. Folia trifoliata, *c.* 3.0-7.0 cm longa (petiolo incluso); foliola orbicularia, ovata ad obovata, obtusa ad acuminata, foliola terminalia 3.0-5.0 x 2.5-3.0 cm, foliola lateralia interdum obliqua, 2.0-2.5 x 1.5-2.0 cm, supra atro-viridia, pilis sericeis albis tegetes formantes, infra dilute viridia, parum pilosa in nervis. Petiolus 1.5-2.0 cm longus; petiolulus 0.5-1.0 cm longus, puberulus. Stipula lanceolata, acuminata, usque ad 3.0 mm longa. Inflorescentia axillaris terminalisve paniculata racemosa, *c.* 5.0-12.0 cm longa. Flores purpurei, *c.* 6.0 mm longi. Pedicellus *c.* 3.0 mm longus, puberulus. Bracteae lineares, 1.0-2.0 mm longae; bracteolae parvae. Calyx *c.* 3.0 mm longus puberulus; dentes tubo parviores, cum bracteis bracteolisque persistentibus. Corolla purpurea; vexillum ovatum ad obovoideum, emarginatum, *c.* 6.0 mm longum, ala plumosa, *c.* 6.0 mm longa; carina breviter rostrata, plumosa, *c.* 6.0 mm longa.

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Stamina diadelpha (9+1), stamen vexillare liberum, *c.* 5.0 mm longum; antherae dithecae. Gynaecium *c.* 5.0 mm longum; ovarium stipitatum pilosum; stylus breviter curvatus, glaber; stigma capitatum. Legumina stipitata, 1.0-2.0 x 0.1-0.2 cm, sericea brunnea, 2-8 articulata, leguminis articuli constricti inter semina, (*c.* 1.0 mm lata), articulus simplicibus *c.* 2.0 mm longus. Semina dilute flava ad saturate flava, *c.* 2.0-1.0 mm.

Typus: Nauti, Chamoli district, Garhwal Himalaya, Uttaranchal, 900 m, 12.x.1998, L.R. Dangwal, 13512 A (Holotypus - GUH); *Ibid*, L.R. Dangwal, 13512 B (Isotypus - GUH).

Desmodium garhwalensis sp. nov.
Dangwal et. Gaur (Fig.1: A-J_1)

The new species is closely allied to *Desmodium elegans* DC., a comparison of both the taxa is given hereunder:

	Desmodium elegans DC.	*Desmodium garhwalensis* sp. nov. Dangwal et. Gaur
1.	Stem glabrous, brown in colour, branches densely hairy.	Stem glabrescent, light brown in colour, branches scarcely hairy.
2.	Leaves *c.* 7.0-15.0 cm long (including petiole).	Leaves *c.* 3.0-7.0 cm long (including petiole).
3.	Terminal leaflets *c.* 7.5 x 5.0 cm, upper side brown, scarcely pubescent on nerves, underside green, matted with white silky pubescent hairs.	Terminal leaflets *c.* 5.0 x 3.0 cm, upper side dark green, matted with white silky pubescent hairs, underside light green, slightly pubescent on nerves.
4.	Petiole *c.* 4.0-7.5 cm long; petiolule *c.* 1.5-2.0 cm long.	Petiole *c.* 1.5-2.0 cm long; petiolule *c.* 0.5-1.0 cm long.
5.	Inflorescence *c.* 15-30 cm long; flowers *c.* 6.0-12.0 mm long.	Inflorescence *c.* 5.0-12.0 cm long; flowers *c.* 2.0-6.0 mm long.
6.	Pods sessile to subsessile, *c.* 5.5-7.5cm x 0.5-0.6 cm, 5-10 jointed; joint of pods not constricted, *c.* 2.0-3.0 mm wide; articles sometimes 'U' shaped, glabrous, 6.0-7.0 mm long.	Pods stalked, *c.* 1.0-2.0 x 0.1 0.2 cm, 2-8 jointed; joint of pods constricted, *c.* 1.0 mm wide; articles simple, silky brown, *c.* 2.0 mm long.
7.	Seeds light brown to black in colour, *c.* 3.0 x 2.0 mm	Seeds light yellow to dark yellow in colour, *c.* 2.0 x 1.0 mm.

Deciduous, light brown glabrescent shrubs, up to 2 m long; branches scarcely hairy. Leaves trifoliate, *c.* 3.0-7.0 cm long (including petiole); leaflets orbicular, ovate to obovate, obtuse to acuminate, terminal leaflets 3.0-5.0 x 2.5-3.0 cm, lateral leaflets sometimes oblique, 2.0-2.5 x 1.5-2.0 cm, upper side dark green, matted with white silky pubescent hairs, underside light green,

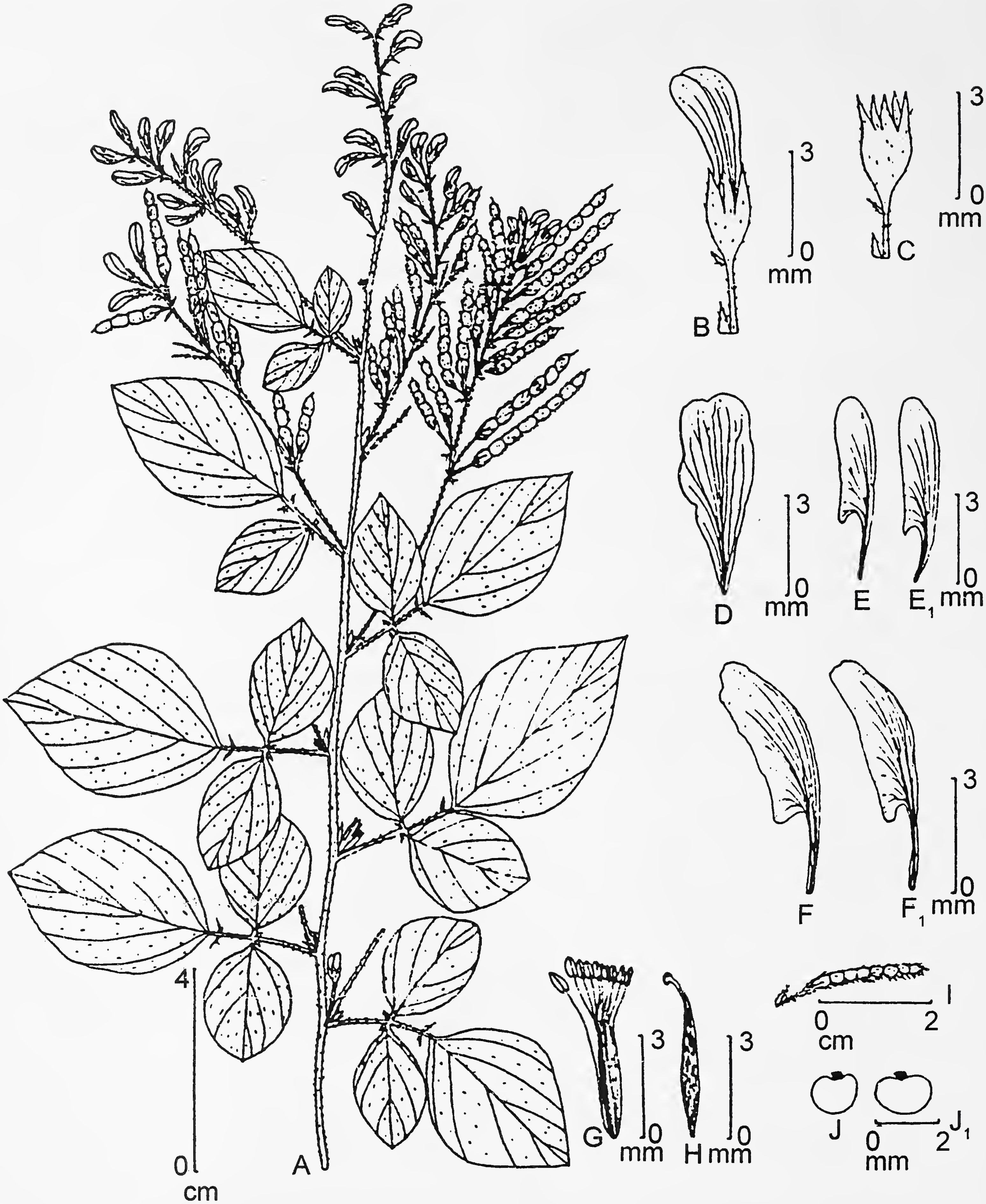

Fig. 1: *Desmodium garhwalensis* sp. nov., A. Flowering and Fruiting branch, B. Flower with bract and bracteoles, C. Calyx, D. Vexillum, $E-E_1$. Wing, $F-F_1$. Keel, G. Stamens, H. Gynaecium, I. Pod, $J-J_1$. Seed

slightly pubescent on nerves. Petiole 1.5-2.0 cm long; petiolule 0.5-1.0 cm long, minutely pubescent. Stipules lanceolate, acuminate, up to 3.0 mm long. Inflorescence axillary terminal, panicled racemes, *c.* 5.0-12.0 cm long. Flowers purple, *c.* 6.0 mm long. Pedicel *c.* 3.0 mm long, minutely pubescent. Bracts linear, 1.0-2.0 mm long; bracteoles small. Calyx *c.* 3.0 mm long, minutely hairy; teeth smaller than tube with persistent bract and bracteoles. Corolla purple; vexillum ovate to obovoid, emarginate, *c.* 6.0 mm long; wing feathery, *c.* 6.0 mm long; keel shortly beaked, feathery, *c.* 6.0 mm long. Stamens diadelphous (9+1), vexillary stamen free, *c.* 5.0 mm long; anthers dithecous. Gynaecium *c.* 5.0 mm long; ovary stipitate, hairy; style shortly curved, glabrous; stigma capitate. Pods stalked, 1.0-2.0 x 0.1-0.2 cm, silky brown; 2-8 jointed, joint of pods constricted between the seeds (*c.* 1.0 mm wide); articles simple, *c.* 2.0 mm long. Seeds light yellow to dark yellow in colour, *c.* 2.0 x 1.0 mm.

Fl. & Fr.: September-December.

Remarks: In dry places along roadside and scrub jungles, associated with *Berberis asiatica*, *Carissa opaca*, *Indigofera atropurpurea* and *Rubus ellipticus*.

Etymology: The plant species is named after the type locality Garhwal Himalaya.

ACKNOWLEDGEMENTS

We thank Dr. N.C. Majumdar, ex-Scientist 'SE' Botanical Survey of India, Kolkata, for the Latin translation of the taxon and the authorities of Botanical Survey of India, Northern Circle (BSD), Dehra Dun and Forest Research Institute (DD), Dehra Dun for herbarium facilities.

■ ■ ■

REVIEWS

1. SAVING WILD TIGERS, edited by Valmik Thapar, 2001. Published by Permanent Black, New Delhi. Pp. 411. Price not stated.

During the last one hundred years, the tiger has travelled a long journey from a 'pest' to an endangered species, and from being the main target of hunters to that of photographers, and now it is also the main target of writers. Perhaps no other Indian animal has been written about as much as the tiger. Valmik Thapar, the editor of this book, has himself written eight books on tigers! I have read most of his books, but never had an uneasy feeling as while reading this book. After a 6-page banal introduction, we are treated to 33 articles, the first being that by Sainthill Eardley-Wilmot, Inspector General of Forests and the last by P.K. Sen, present Director of Project Tiger. The illustrations in these two articles symbolize the tragedy and indignity that the tiger has suffered during the last 100 years. While Eardley-Wilmot is shown standing proudly in front of three slain tigers and one leopard, Sen is counting tiger bones! Is this all that will be left of this grand animal?

Valmik has selected some good writers who have made an impact on tiger protection. I particularly liked the article by E.P. Gee, Richard Perry, Kailash Sankhala and Charles McDougal. The selection of illustrations/pictures could have been better. We are treated to an article "An Appeal for the Preservation of WildLife" by Stanley Jepson with his wife sitting on a large, handsome, slain tiger, and the author-hunter proudly sitting with his gun on a sloth bear, and his hat disdainfully placed over the head of another sloth bear. The vehicle in the background with five Indians who must have helped Jepson in this slaughter, portrays the tragedy of Indian wildlife in bygone days. Even the more contemporary picture printed with Melvin Sunquist's article "Radio-tracking the Tiger (p. 197) looks out of place. What is he doing with the gun, even if it is a tranquilizing gun? A picture of a radio-collared tiger would have been more appropriate.

Besides the inappropriate pictures, the quality of printing leaves much to be desired. Most of the pictures are very dark, and the ink smudges if you touch them. Perhaps the publisher "Permanent Black" wanted to leave a permanent impression, on the fingers, even after one put down the book. *Et al.*, meaning 'and others', is a Latin phrase that most authors do not know how and where to use. If there are three or more than three authors, the name of the first author is followed by *et al.* It is used only in text for brevity, but in the reference section, all the names are cited, even if there are 20 authors. I was surprised to see John Seidensticker *et al.* (p. 341) and Sarah Christie *et al.* (p. 373) in the title of the chapters. Full names of all the authors should have been given.

If we overlook these drawbacks, SAVING WILD TIGERS is an interesting book. E.P. Gee's writing in 1964, in his famous book THE WILDLIFE OF INDIA, talks about India's burgeoning human population "This increase is by far the greatest threat to wild animals...". This was written when India's population was 440 million. Now we are more than a billion and demographic prediction indicates that our population may stabilize only at 1.4 to 1.5 billion — a billion more than at Gee's time. Fortunately, his prophecy has not come true *yet*, but will we be able say this with surety in AD 2100? I am afraid that future generations will write that farsighted people like Valmik Thapar made attempts to save wild tigers, but failed as all the tigerland was occupied by human beings.

■ ASAD R. RAHMANI

2. LIFE'S DEVICES: THE PHYSICAL WORLD OF ANIMALS AND PLANTS by Steven Vogel. Universities Press (India) Ltd., Distributed by Orient Longman. © Princeton Press 1988. Pp 368 (16 x 24 cm). Rs 275/-

Did you ever think of a link between Venturi tubes and prairie dogs, or a leaf and its petiole as a cantilever beam? Read about how sponges use tiny, stiff spicules in an easily bent collagenous meshwork to produce their own brand of reinforced concrete. It occurs to you as you digest this, how basically similar that is to the dry straw and mud plaster used in Indian villages to this day!

This book is about physical phenomena in the biological world, and the author has picked several living functions of animal bodies to demonstrate some very basic physical principles. The book is like an illustrated walk through nature, helping us to make sense of the links between biology and physics, beyond the simple hinge joints and ball and socket joints that we are already familiar with. An interesting example is that of the physical principles affecting the mating of hawkmoths. The structure of the male hawkmoth's large feather shaped antennae is such that it is intended to pick up the attractant pheromones released by the females located miles away. The author demonstrates how problems of air viscosity and diffusion affect the air flowing past or through the antennae. The result is that less than 18% of the approaching air stream is actually able to flow through and make contact with the chemoreceptors on the male's antennae, 70% of which are dedicated to this vital task alone. Thus, we fully appreciate the incredible sensitivity of this system that overcomes the vast distance between prospective pairs of moths.

Steven Vogel has explained all the terminology of physics in the earlier chapters, and as he proceeds, the work increasingly revolves around its biological focal point instead. I found my 30 years old memory of junior college physics not quite adequate to grasp the fascinating demonstrations of physical principles as applied to living creatures. The book will help to remove from our minds deeply ingrained artificial dockets where we try to file away information in "subjects", Physics, Mechanics, Dynamics, Physical Chemistry, as separate from Biology.

The author's literary bent of mind shows in the text, particularly in this line on page 101. "The surface of a liquid is like the brow of a thinker – a perturbation wrinkles it into waves". Also in the delightful quotations used for chapter headings. "Blood is thicker than water" is Sir Walter Scott's comment on viscosity! Unfortunately, the very first one, on page 3, "Throw physic to the dogs, I'll none o' it" [Shakespeare, Macbeth] does not quite fit. For Macbeth, physic meant what we call medicine or a drug, not physics in the sense of the book under review. On page 3 also, I found the only typographical error worth mentioning, as it spoils the first taste of a book, so important to decide how far to read on: though instead of through.

You will enjoy Vogel's delightful turn of phrase, so important to a popular science writer as well as to a lecturer: quote "The fall of an elephant is a matter of the utmost gravity". And you may overcome an antipathy to explore the mystifying territory beyond "purely biological" writing as I did. In all, a delightful, contemporary, 'need of the hour' title.

■ GAYATRI UGRA

3. BIRDS OF PUNE, Kalpavriksh in collaboration with Centre for Environment Education, Ahmedabad, 2001. Pp 136. Price Rs. 50.

Besides Usha Ganguli's book BIRDS OF THE DELHI REGION, BIRDS OF PUNE is perhaps the only book on birds of any district or city. It is interesting to know that 23 people and two institutes collaborated to bring out this small and beautifully designed book of 136 pages, profusely illustrated with black and white and colour illustrations. Out of the 400 species reported from Pune district, 100 common species are described in easy colloquial language. The book is for amateurs, so the birds are classified as 'Brightly Coloured Birds', 'Muted Coloured Birds', 'Sober Yet Smart' (whatever that may mean), 'Long-legged Birds'. 'Birds with Prominent Bills' so on and so forth. I do not know the efficacy of such a classification, especially when 'brightly coloured birds' are shown in black and white! Interestingly, even the pitch black jungle crow is included under 'brightly coloured' birds. While it is a lovingly smart bird, by no stretch of the imagination can it be considered as colourful.

The chapter 'The Fun of Birdwatching' is fun to read with good tips on birdwatching. 'Bird Identification Step by Step' is also well written. CEE should bring out this chapter in the form of a small booklet or a brochure for wider circulation, because the tips are valid for any region. For serious bird watchers looking for good birding areas in Pune district, important sites are described, some even with maps. A checklist consisting of 400 species recorded in Pune district makes this book valuable for science. Stray or unusual records (e.g. Grey Hypocolius sighting in Valvan dam, Lonavla) are also included. Some of these records deserve publication in the *Journal of the Bombay Natural History Society*. Most of the colour illustrations are accurate, except the crow-pheasant in Plate K. The wings and back are both rufous in this bird, but the book shows it with a black back.

The importance of the book is enhanced by information such as habitat-wise birding areas of Pune, references for further reading, newsletters and magazines for birdwatchers, bird call audio-cassettes and birdwatching organizations in Pune. Citizens of Pune, quirkily called Pune-ites, are lucky that they have experienced ornithologists like Prakash Gole and Anil Mahabal, photographers like Saleel Tambe and organizations like Kalpavriksh and Centre for Environment Education who joined hands to bring out an interesting book.

■ ASAD R. RAHMANI

MISCELLANEOUS NOTES

1. HIGH-TENSION ELECTRIC POLES USED AS NIGHT ROOST BY TROOPS OF HANUMAN LANGUR *PRESBYTES ENTELLUS* AT NAHARGARH WILDLIFE SANCTUARY, JAIPUR

A 132 kw high-tension electric line passes through the Nahargarh Wildlife Sanctuary, Jaipur. At night, electric poles of this line are used as roosting sites by the Hanuman langurs *Presbytes entellus*. There are three troops of langurs, which keep to the eastern part of the Sanctuary. They either roost on the roof and cornices of the three old multistoried *shikar* (hunting) towers or on poles of high-tension electric line. It was also observed that they regularly change their roosting sites.

Anogeissus pendula, the main tree species of the Sanctuary, generally does not grow very tall in nature, and is hence never used for night roosting. However, some tall trees of *Holoptelia integrifolia* are sometimes used for roosting.

Leopard (*Panthera pardus*) is the main predator of langurs in the Nahargarh Sanctuary. Perhaps to avoid the attack of leopard at night, troops of langurs prefer safer night roosts like the top of buildings and high-tension electric poles.

February 7, 2001 SATISH KUMAR SHARMA
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2. ABNORMAL WEIGHT AND LENGTH * OF THE INDIAN PANGOLIN *MANIS CRASSICAUDATA* GRAY, 1827, FROM SIROHI DISTRICT, RAJASTHAN

On September 5, 2000, an Indian pangolin (*Manis crassicaudata* Gray) was seen in the campus of the J.K. Cement factory near Banas railway station in Sirohi district of Rajasthan State. Since the animal was not safe in the factory campus, it was captured with the help of local forest officers and transferred to the Zoological Garden, Jaipur. At the Zoo, the full grown male was thoroughly checked by the zoo veterinarian, and its weight and length were recorded as below, and are compared with Prater (1980) and Roberts (1997) in Table 1.

TABLE 1
BODY MEASUREMENTS OF PANGOLIN CAUGHT FROM SIROHI DISTRCT COMPARED WITH PRATER (1980) AND ROBERTS (1997)

Parameters	Recorded/ Referred by Roberts (1997)	Recorded/ Referred by Prater (1980)	Recorded at Zoological Garden, Jaipur
1. Body Weight	11.3-17.17 kg	-	32.2 kg
2. Total body length	122 cm	105-120 cm	170 cm

It is evident from Table 1 that the specimen caught from Sirohi district is of abnormal weight and length, which is worth placing on record. The specimens measured by Prater and Roberts may have been immature.

Since the food habits of pangolin are peculiar, and its rearing is not an easy job in captivity, the pangolin was safely released in its natural habitat.

ACKNOWLEDGEMENTS

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*It must be noted that these are measurements of skins and not of live animals or measurements taken before skinning. — Eds

3. SCAVENGING BY STRIPENECKED MONGOOSE *HERPESTES VITTICOLLIS* ON A TIGER KILL IN PERIYAR TIGER RESERVE, KERALA

On October 17, 2000, around 1730 hrs, we were observing a three-day old sambar (*Cervus unicolor*) stag carcass, partially eaten by tiger, by the lake at Manakavala area of the Periyar Tiger Reserve. First an osprey (*Pandion haliaetus*) was seen feeding on the kill. Later, a wild pig (*Sus scrofa*) approached the kill, fed on it for about 10 minutes and then suddenly bolted. After about half an hour, a stripenecked mongoose (*Herpestes vitticollis*) came to the kill and started eating. It entered the open belly and remained inside for about five minutes. Then it withdrew into the bushes, but returned after half an hour with another stripenecked mongoose. They came near the kill, but immediately turned around and ran into the bushes. Stripenecked mongoose is frequently seen in Periyar Tiger Reserve. However, scavenging by the species is being reported for the first time. In fact, nothing much is known about the feeding habits of the species, even though it is frequently seen in other areas of the Western Ghats.

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4. NOTES ON THE FOOD HABITS OF STRIPED HYENA *HYAENA HYAENA* LINN.1758 IN SARISKA TIGER RESERVE, RAJASTHAN

Though the striped hyena *Hyaena hyaena* is widely distributed in India (Prater 1980), information on its status, distribution and ecology is meagre. Hyenas are known to be scavengers, but occasionally they carry off live sheep and goats, and quite often stray dogs (Prater 1980). Between July 1988 and December 1990, 26 hyena scats were collected from Sariska Tiger Reserve, Rajasthan (76° 17'-76° 34' N; 27° 5'-27° 33' E). The scats were washed in a sieve and oven dried at 60 °C. At least 20 hairs were taken from each scat (Mukherjee *et al.* 1994) and examined under a microscope. Identification of prey species was based on medullary pattern of hair as described by Moore *et al.* (1974). Except one, all the scats contained single prey species. Chital (*Axis axis*) remains were found in 35% of the scats, followed by domestic cattle *Bos indicus* (17%), goat (14%), nilgai *Boselaphus tragocamelus* (14%) and rufoustailed hare *Lepus nigricollis ruficaudatus* (7%). The remains of an unidentified bird, an unidentified rodent and fruit of *Zizyphus mauritiana* were found in 13% of hyena scats. Chital, nilgai and domestic cattle remains found in hyena scats are likely to come from predation or scavenging.

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5. ATTITUDES TOWARDS WILDLIFE CONSERVATION IN RANCHI DISTRICT — A CASE STUDY

Participation of people in land use decisions is a new and inspiring concept in Protected Area (PA) Management. Conservation of wildlife requires the cooperation and goodwill of the people living in and around the wildlife habitat. But adopting these concepts implies a fundamental shift away from the traditional approaches to protection and it cannot, therefore, be expected to determine management practice overnight (Berkmuller 1986). Even dedicated Protected Area Managers who have successfully protected their PA against tremendous odds, against the opposition of the locals and at great personal risk, are not easily convinced by this concept. All said and done, the conflict with the locals continues to draw the attention of managers in most of India's protected areas. The situation is getting more complex with the passage of time and factors like population explosion.

Lack of resources, both man and material, are a major hindrance to the effective management of a PA, but the most important factor is the attitude of the locals towards conservation. It is not necessary that people living near predators invariably have a negative attitude towards them. Respondents to a questionnaire in Alaska, for example, had the most positive perceptions of the wolf in a survey undertaken across states in the USA. People with a positive attitude to predators indicate greater interest in protecting wildlife and natural habitats (Kellert 1985). It is difficult to take conservation action which runs against the general beliefs or attitudes of the local people, and most decisions are influenced by attitudes rather than rational considerations. Values and attitudes are rooted in personal experience and upbringing.

The study area chosen was Karra CD Block of Ranchi district, with block headquarters situated around 30 km west from Ranchi town. Karra CD Block, one of the 20 CD Blocks of the district is badly affected by human-wildlife conflict particularly involving elephants and bears, as is evident from the number of deaths, injury, crop and house damage caused by wildlife as recorded by the Forest Department.

To investigate the levels of awareness about wildlife conservation and allied aspects, and to find out the attitudes of the people, a questionnaire survey was undertaken in the study area.

148 individuals from 25 villages of Karra CD Block, answered the questionnaire. Information regarding their age, ethnic status, literacy, profession was also gathered (Tables 1 & 2). Awareness scores were grouped as high, medium and low, while attitude scores were grouped as positive, neutral and negative.

The results from the questionnaires were analysed as follows: Answer to questions testing the attitudes and awareness were graded 1, -1 and 0, depending on the level of the answer given by the respondent i.e. score of 1 given to positive, -1 given to negative and 0 to neutral. The points for the answers were summed to get an attitude and awareness score. To test the Null Hypothesis, i.e. to determine if the central locations of

TABLE 1
AGE STRUCTURE AND ETHNIC COMPOSITION MATRIX OF THE RESPONDENTS

	Ethnic Group (No.)			
Age (in Years)	S.C.	S.T.	Others	Total
< 20	6	20	11	37
21-30	2	19	9	30
31-40	3	14	6	23
41-50		9	2	11
>50	6	28	13	47
Total	17	90	41	148

S.C.= Scheduled Caste; S.T.= Scheduled Tribe

TABLE 2
LITERACY LEVEL AND THE ETHNIC COMPOSITION OF RESPONDENTS

	Ethnic Group		
Literacy level	S.T.	Other than S.T.	Total
Literate	41	38	79
Illiterate	49	20	69
Total	90	58	148

S.T.= Scheduled Tribe

distributions of the two populations (Awareness and Attitude) are the same, it is assumed that their population distributions are identical. In such cases, the Mann-Whitney U test was used for testing the Null Hypothesis. Scores were compared by Mann-Whitney U test and the number of respondents in the different categories were compared by Chi-square test. Difference between attitudes scores and awareness scores was calculated as U = 3224 and P = 1. The significant difference between these two scores indicates that the central locations of the attitudes and awareness among the people towards wildlife conservation were identical.

The tribals comprised 60.8% of the respondents and non-tribals 39.2%. To test another Null Hypothesis that attitudes and awareness do not depend on literacy ethnicity, the Chi-square test was used. Fewer tribals (45%) were literate compared to non-tribals (65%) (χ^2=5.65, d.f.=1). Greater literacy among non-tribals influenced their attitudes and awareness about wild animals than tribals (χ^2=13.98, d.f.= 2, χ^2 9.78, d.f.=2). There is a weak but significant positive correlation between attitude scores and awareness scores (r=0.18 P>0.05, n=148) of respondents.

From the above analysis, it can be concluded that the attitude and awareness amongst the villagers towards wildlife conservation are significantly different. Individuals from the scheduled tribe (ST) had lower attitude and awareness scores towards wildlife conservation issues than non ST individuals. This probably is due to their lower literacy level. Further, it was observed that literacy directly influences the attitudes and awareness of the villagers towards wildlife conservation.

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6. SOME CLARIFICATIONS REGARDING THE LESSER FLAMINGO *PHOENICOPTERUS MINOR* AND THE CRAB PLOVER *DROMAS ARDEOLA*

Concerning the lesser flamingo *Phoenicopterus minor* Geoffroy, the impression one would gain is that the main stronghold is Sambhar Lake. This is wrong — the main breeding and later dispersal centre is the Little Rann of Kutch where a huge colony bred

successfully in 1998. Its breeding in the area was suspected for long and first confirmed by Vora of the Gujarat Forest Department. Nesting had been reported earlier by Sálim Ali and Shivrajkumar in the Great Rann, alongside the greater flamingoes *Phoenicopterus ruber* Linn.

There are immense flocks during winter in salt pans around Saurashtra. I was shown these in the Bhavnagar salt pans and similar huge flocks at Hathat further west on exposed tidal flats by Dharmakumarsinhji. Also, a massive flock spends much of the year at Porbandar on the west coast of Saurashtra, where a special sanctuary has been declared in the city! I was the first to report a largish flock in Chilka during the survey I conducted for BNHS with P.B. Shekhar. This has been reported in the *JBNHS* (Khacher, 1966, 63: 290-297)

I remember Dharmakumarsinhji and us — Shivrajkumar and myself — considering the huge flocks along the Saurashtra coast as coming from East Africa. Now I suspect there is an Indian population centered on Gujarat and dispersing widely across the Subcontinent east to Lake Chilka and south to Pt. Calimere. I would not be surprised if this flamingo is commoner in Sindh and also reaches the saline lakes of Baluchistan rather more frequently than believed.

To end on a rather personal note, the large flocks of crab plovers *Dromas ardeola* Paykull were "discovered" by me first in December, 1969 when the Jam Saheb had organized a boat trip for me. I have referred to this in my account of 'The Birds of Gujarat' *JBNHS* 93(3): 331-373. From what T.J. Roberts writes, he has gained the impression that the discovery was made by Dharmakumarsinhji, whom I showed a very large flock, which he photographed, near Ghargha south of Bhavnagar. This was the first time he realised that crab plovers were not uncommon. Interestingly, Grimmett and the Inskipps (2000) in their BIRDS OF THE INDIAN SUBCONTINENT have not shown crab plovers occurring in the Gujarat section of the seacoast, though they have mentioned the birds having "traditional roosts" and state that they are "mainly crepuscular and usually very wary." They do not have roosting sites, but like all inter-tidal mudflat waders, they collect on a beach or near an inundated shoal as the water rises. All the birds of a flock of a particular reef get restricted to one point. Should the reef get entirely submerged, as often happens during spring tides, the flock flies in low, swift direct flight across the open water to some nearby island, where it might happen that another flock has been pushed together by the water. Interestingly, crab plover never go behind sand dunes to rest during high tide on open mud flats, as other waders do. They will skirt headlands along the surf or fly across open water. They are certainly not crepuscular and, particularly when resting at high tide, they are ridiculously confiding, allowing very close approach as Dharmakumarsinhji had done to shoot his first photograph of the flock at Ghoga. They feed between the high tide marks, day and night. In BIRDS OF PAKISTAN, T.J. Roberts writes "In Pakistan it occurs very sparsely along the Mekran coast and occasionally in the Indus Delta, but it seems likely that numbers pass through on migration to wintering grounds in the Rann of Kutch". They do not winter in either the Great or the Little Rann of Kachhch, but do so largely in the Gulf of Kachhch, where the total numbers on all the tidal mudflats and coral mangrove islands must be far greater than the 2,500 and 5,000 "revealed" by the 1984 Oxford University expedition to the Gulf of Kachhch. This clarification is needed so that it does not get repeated again and again, as indeed observations on the birds' crespuscular habits and wary disposition have been.

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7. OCCURRENCE OF *GALLOPERDIX* SPP., FAMILY PHASIANIDAE IN NORTHWESTERN MADHYA PRADESH

M.K. Ranjitsinh (*JBNHS*, 96(2): 314) referred to the occurrence of the painted spurfowl (*Galloperdix lunulata* Valenciennes) in a few places in Rajasthan and asked whether it is sighted in the forests of northwestern Madhya Pradesh. I have seen it on at least six occasions between 1992 and 1997 in Madhav National Park (78° 15'-78° 30' E and 24° 50'-25° 55' N) in Shivpuri district. This park has northern Dry Deciduous Mixed Type forest and two lakes. The painted spurfowl was always sighted in the forest on the slopes along the *muram*, road near the banks of Sakhya Sagar lake in an area where there is an iron bridge between the points known as Landing Station Nos. 3 and 5.

On the eastern side of Sakhya Sagar there is a dam wall. The water seeps through the bottom of the wall round the year, flowing in a drainlike channel through the dense undergrowth towards the second lake, Madhav. In this area, the red spurfowl (*G. spadicea*) is seen frequently.

In 1996, the painted spurfowl was sighted in Palpur-Kuno Sanctuary about half a kilometre away from Kuno river and Kuno Dak Bungalow along the Pohri-Sheopur road in Morena district. These two species have been regularly seen in northwestern Madhya Pradesh.

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8. OBSERVATIONS ON THE MATING BEHAVIOUR OF THE INDIAN SARUS CRANE *GRUS ANTIGONE ANTIGONE* IN THE WILD

(*With four text-figures*)

Reproductive behaviour is a typical sequence of behaviour, which includes courtship, copulation, egg laying, incubation, rearing and parental care. The breeding behaviour of various cranes has been studied widely, in captivity and in the wild (Johnsgard 1983, Van Ee 1966, Sauey 1976, Tacha 1981, Masatomi 1983, Masatomi and Kitagawa 1975, Voss 1976 and Tao and Peixun 1991). Except for general courtship display and mating of the Indian sarus crane *Grus antigone antigone* (Ali and Ripley 1983, Walkinshaw 1973, Gole 1987) sequential behaviour leading to mating is not described.

This paper is a preliminary study of reproductive behavioural patterns observed and recorded in the field. The obserservations are divided into three stages: 1. Duetting 2. Dancing and 3. Copulation.

This study was carried out in the agricultural landscape of Matar tehsil of Kheda district, Gujarat. Matar tehsil has more open vegetation than the other nine tehsils of Kheda district. The climate is semiarid, tropical monsoon type. Southwest monsoon arrives in the third week of June and continues till September end. The average monthly maximum temperature ranged between 41.8° C in May and 27.0° C in December. Average monthly minimum temperature ranged between 11.3° C in January and 26.4° C in July. Average annual rainfall of the district is 840 mm. Paddy and pearl millet are the major cereals grown in the monsoon (kharif crops).

The sarus cranes in flock or family were observed throughout the breeding period from Jul.-Nov. 1997 and 1998 in the wild. Five pairs

were observed in detail using a telescope (20x), photographed and sketched. Each pair was observed from a vertical distance of 300 m. Other pairs with interrupted reproductive behaviour were also studied when they entered the scanned area.

The behavioural responses of both sexes need not always leads to successful mating. As reported in case of *Grus japonensis* (Masatomi and Kitagawa 1975) the process is often interrupted by factors like age, sexual maturity, pair bond and to some extent the surrounding habitat. The cranes dispersed widely, forming a large, isolated territory. The following stages were observed:

1. **Duetting**: Duetting was exhibited by the pair, and display by a single crane was rarely observed. The pair generally called in unison as a part of duetting. The male first gave a note followed by 2-3 shorter notes by the female. This unit 'M1 + F2-3' was repeated in succession. It was observed that duetting of a pair may provoke the same response in its neighboring pair.

The cranes were seen duetting in different postures, however, the head of both the sexes was always held high; wings semi-closed, closed, or obliquely raised, sometimes drooping (Fig. 1).

2. **Dancing**: A crane in grazing posture stoops with retracted neck, sometimes spreading its wings, and makes a bouncing movement. It leaps up to a few metres above the ground.

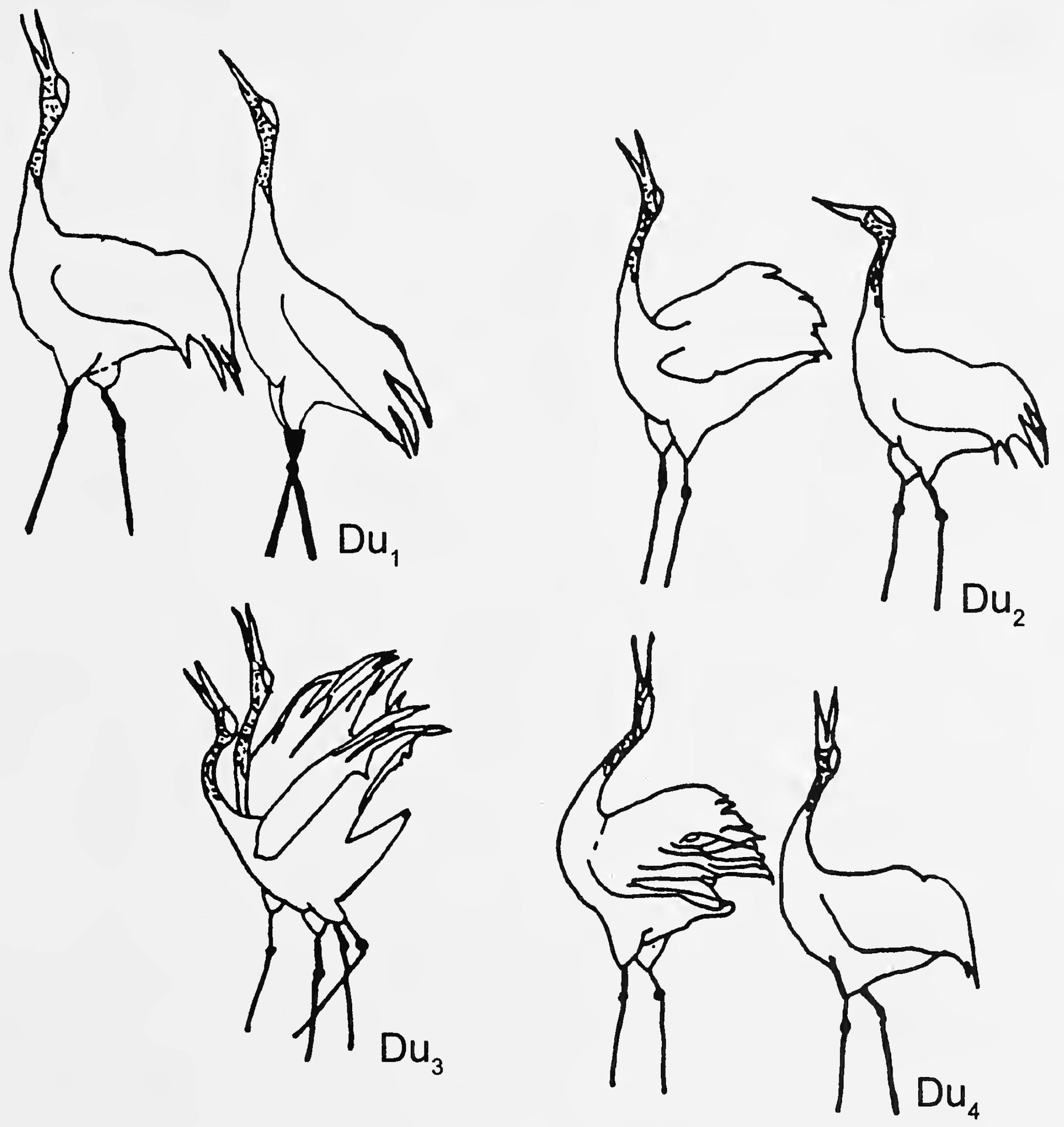

Fig. 1: Inter individual posture observed during duetting (Du) of the Indian sarus crane, Semiclosed-wing duetting (Du_1), Closed-wing duetting (Du_2), Obliquely-raised wing duetting (Du_3), Drooped wing duetting (Du_4)

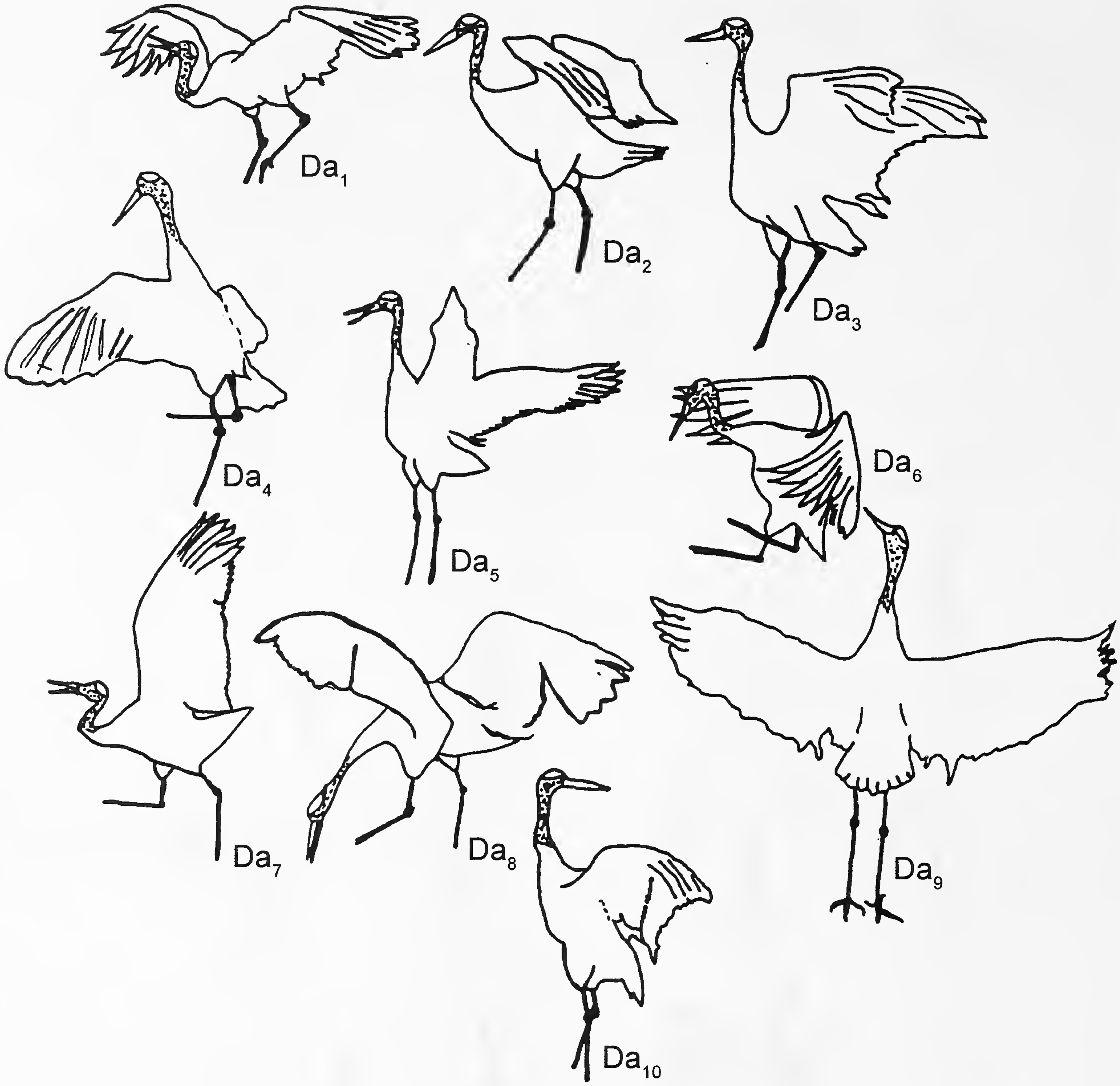

Fig. 2: Inter individual postures during dancing (Da) of the Indian sarus crane; Stooping (Da_1), Stooping (Da_2), Pre-leaping (Da_3), Leaping (Da_4), Leaping (Da_5), Floating (Da_6), Rushing (Da_7), Picking-up (Da_8), Throwing (Da_9), Turning (Da_{10})

Floating down, it momentarily flaps the wings, and the legs are bent parallel to the body. The male often chases the female while dancing, which ultimately ends in calling vigorously or becoming ready for mounting. A peculiar throwing movement was seen when a dancing crane suddenly bowed its neck up and down several times, immediately picked up a plant from the ground and threw it with a sideways jerking of the neck. The same was done by the mate. This was also observed during nest building (Fig. 2).

3. **Copulatory behaviour**: The elaborate sequence of mating between a pair is shown in Figs 3 and 4.

a) The male, often emitting a low pitched precopulatory call, raises its bill about 30°, its neck

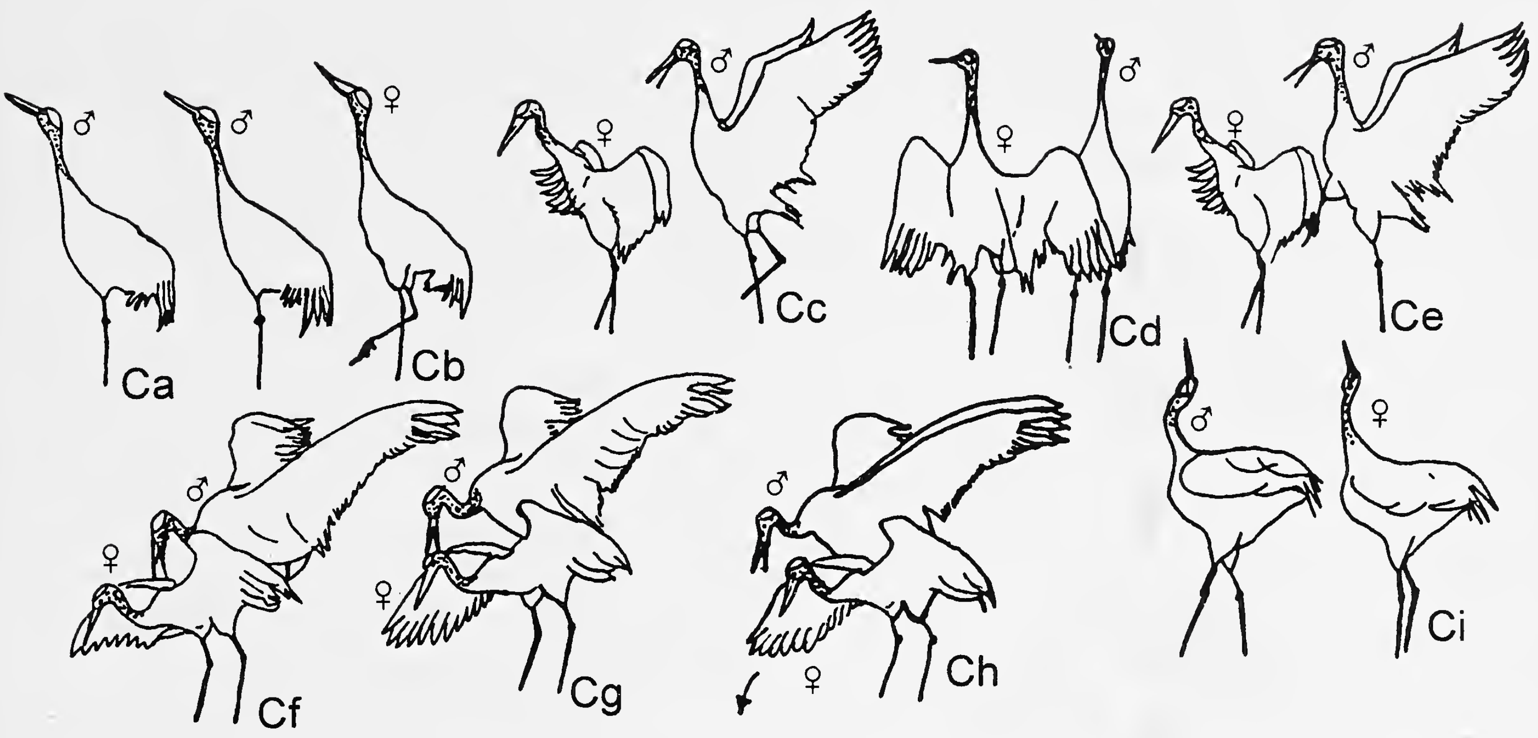

Fig. 3: Inter individual postures during copulation (C) of the Indian sarus crane; Bill raising (Ca), Bill-raising (Cb), Back-turning (Cc), Wing-spreading (Cd), Stepping (Ce), Mounting (Cf), Being-mounted (Cg), Sliding-down (Ch), Post copulatory display or Arching (Ci)

extended obliquely upward (Bill raising Ca). After a minute or so, the crane generally begins to walk with a head-up posture to an open place.

b) Seeing this, the female adopts the same posture and follows the male.

c) Selecting a suitable place, the female turns her back on her mate. Immediately, the male makes its characteristic, vigorous, shrill, copulatory call, which continues with small interruptions until copulation is complete.

d) The male approaches the female very slowly, with long steps, and the female spreads her wings almost open (wing spreading Cd). At the final stage, the male makes a low pitched call, and comes close to the female, who retracts her neck slightly upwards, points the bill downwards and crouches slightly.

e) Flapping its wings regularly, the male suddenly steps up to the female (Stepping up Ce) places his toe on her back, and grips the female by hooking the claws on to her wings. With a little pressure on her back, the male lifts his other leg. The female bends slightly forward and her body lies almost horizontal to the ground.

f) The male squats on the female's back, hooking on his toes. The female spreads her wings wide and points her bill obliquely downwards. Both are silent.

g) The male leans back, the female remains horizontal, their cloacae in contact (Cloacal kiss Cg). The female's head is level with her body, but the bill may touch the ground.

h) Just after copulation, the male calls aloud, lowers himself and slides down, always over the head of the female. After dismounting, the female stands still for a few seconds, and then both bow together and perform a ritual dance, calling in unison (Arching Ci).

In four pairs, the female preened her thigh after dismounting, while the male stood upright, with his head high. Then both performed a ritual dance. In other cases, stages (a) to (f) were observed, but not copulation. In such pairs, the female runs ahead on being chased by the male. They stop, dance, both the sexes jump and then exhibit irrelevant behaviour like preening and feeding.

Duetting was performed in various

Fig. 4: Sequential line diagrams in sequence of mating behavior of the Indian sarus crane

situations, before or after copulation, at relief of incubation, against intruders in territory. Duetting maintains the synchronisation of reproductive rhythm (Masatoni and Kitagawa 1975). The call of the male, followed by the female, was well described as antiphonal song by Armstrong (1963), where the female adds her utterance so promptly that it sounds like a single stereotyped song. Therefore, unison calling need not be a synchronous duet (Walkinshaw 1949).

The ritual dance is the outcome of hormone-induced physiological changes within the body due to excitement, just before copulation. However, dancing has been observed even at feeding place by the gathering of the flock, as in Tancho (Iwamatsu 1966). It was also observed in a flock of 50 cranes during the present study, and has been reported earlier (Gole 1987). Interspecific dance with a young sandhill crane was recorded by Masatomi (1973). Dancing can occur regardless of the number of birds, age, sex, season, place or time of day (Walkinshaw 1949). However, it was most common prior to the initiation of breeding season.

The reproductive behaviour is genus- and species-specific (Masatomi 1983) and some modification of behaviour probably occurs due to the prevailing conditions (Tao and Peixun 1991). Masatomi's (1983) captive study on eastern sarus *Grus antigone sharpii* revealed similarity with the Indian sarus crane *G. a. antigone*, but the calling during and after copulation were different in captivity and this study in the wild. The difference may be in the subspecies.

Successful copulation could be judged as having been achieved by the response of the mates to each other. The male's bill raising and the female's submission by wing-spreading appear to be a prerequisite for copulation, but not mandatory

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9. A HERONRY AT TRAJ IN KHEDA DISTRICT, GUJARAT

Kheda district is reckoned to be among the important bird areas of Gujarat, notable for its expanse of inland wetlands. Besides having a high density of sarus crane *Grus antigone* (Singh and Tatu 2000) this area also holds many heronries, such as at Traj and Pandoli village ponds (A.J. Urfi & Dilhaz Jaffrey, unpubl. data). In this note, I record the Traj heronry, which was studied during June-October, 1999, in some detail.

The village pond at Traj, estimated to be over 10 acres, is approximately 20 km from National Highway No. 8, between Ahmedabad and Kheda. Since the pond is fed by a canal, there is water all year round. In this regard, it is different from many other village ponds in Gujarat, which dry up during the summer and are replenished only during the monsoon. Traj pond is bisected into two interconnected halves by a low-lying bund wall. One part is shallow and overgrown by the Indian lotus (*Nelumbo nucifera*), while the other is deeper and has a small island with several *Acacia* and *Ficus* trees.

On our first visit to Traj on June 15, we observed that about 200 Asian openbill-stork (*Anastomus oscitans*) had collected on the trees on the island, along with the little egret (*Egretta garzetta*) and little cormorant (*Phalacrocorax niger*). On a second visit on June 21, the nesting of these species was confirmed and on July 14, new breeding species Oriental white ibis (*Threskiornis melanocephalus*) and median egret (*Mesophoyx intermedia*) were observed to have also joined the heronry. Even at this stage, the openbill-stork were seen flying about on nest building chores, such as collecting fresh leafy twigs to add to their nests. On the fourth visit on August 28, chicks of Asian openbill-stork, white ibis, median egret and cattle egret (*Bubulcus ibis*) were observed. One darter (*Anhinga melanogaster*) and 4 painted stork (*Mycteria leucocephala*) were also observed, leading us to

suspect that these species would nest here at an appropriate time. However, these birds were not seen again during a trip on October 7. By now, the chicks of all heronry birds had reached subadult proportions. Since the island is some distance away from the bund walls surrounding the pond from which observations can be made, it was not possible to ascertain the number of nests of each species on any occasion.

Other than the heronry, the wildlife value of Traj village pond has some other aspects too. On most of our visits we encountered quite high numbers of sarus crane, 68 in the shallow part of Traj pond on July 14 being the highest number. Other types of waterbirds viz, rails, kingfisher, ducks etc. were also seen here. Another interesting feature is the presence of mugger (*Crocodylus palustris*) in the deep part of the Traj pond (Vijaykumar 1997). On our visits five mugger were observed, of which three were large specimens (*c.* 3m) and two smaller individuals (1.2-3m). However, we did not come across any instance of mugger predating on adult or juvenile birds of the heronry.

For ornithologically significant village ponds in the Ahmedabad region, a conservation and education strategy has been chalked out by Urfi and Nareshwar (1998). This plan envisages population monitoring of heronry birds and simple interpretation and community sensitization programs.

I wish to thank Dilhaz Jaffrey, E.K. Nareshwar and Narendra Nethwa for company on field trips. I am grateful to Mr. K.V. Sarabhai, Director, Centre for Environment Education, Ahmedabad, for encouragement.

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10. INTERACTION BETWEEN SIBERIAN CRANE *GRUS LEUCOGERANUS* AND CHECKERED KEELBACK SNAKE *XENOCHROPHIS PISCATOR* IN KEOLADEO NATIONAL PARK, BHARATPUR

On July 1, 1997 while collecting information on the time budget and activity patterns of four released Siberian cranes *Grus leucogeranus* in the Keoladeo National Park, I noticed a crane hurriedly pacing up and down a distance of *c.* 10 m. Through my telescope I noticed a checkered keelback water snake *Xenochrophis piscator* holding on to the crane's face. The one metre long water snake had wrapped itself around the crane's neck. The crane tried hard to shake the snake off her face. She tried removing it by vigorously shaking her head and neck, and also with her feet. Three other cranes foraging nearby stopped feeding and looked nervously at the affected crane that struggled for more than ten minutes, before the snake loosened its grip and dropped off. After the snake had left, the crane splashed water on her face and neck for some time and started preening. The other cranes also resumed their activities.

In 1996-97, the water hyacinth *Eichhornia crassipes* had choked most of the marshes in the Park because of which water snakes had become abundant. The Park Management was getting the hyacinth removed manually as part of the Park's

Vegetation Management. On an average, 10-12 workers involved in this task were bitten every day by water snakes (Park Director, *pers. comm.*). There were heaps of water hyacinth lying where the cranes were foraging. It is possible that the snake was lying in wait for prey.

Water snakes are known to be pugnacious, not letting go of their prey till it dies, but not strangulating it. They are known to feed on small mammals, birds, fish and amphibians (Daniel 1992, THE BOOK OF INDIAN REPTILES). The huge pythons *Python molurus* present in the Keoladeo marshes could be considered as potential predators of cranes. I have not come across any reference on snake-crane interaction and think it is worth recording.

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11. TWO INTERESTING AVIAN RECORDS FROM KUTCH, GUJARAT STATE

This note concerns the occurrence of *Glareola pratincola* (Linnaeus) and *Monticola cinclorhynchus* (Vigors) in Kutch. Earlier records mention the occurrence of the former, but since the nineteenth century it has not been recorded in this region. In recent years, it has been seen in 1992 (Himmatsinhji, *JBNHS 96(2)*: 316-317) and 1999. The latter has been recorded for the first time and it was seen on January 27, 1985 and March 9, 1999.

While MKH and SNV watched water birds from a location on the Bhuj-Pachham road (*c.* 30 km north of Bhuj) on October 18, 1992, a pratincole flew in and settled down on the marsh. Soon thereafter, a juvenile bird also came down nearby. We remained there for some time, but saw no interaction between them. These individuals had deeply forked tails, and from details of the adult coloration, observed through binoculars and a telescope, appeared to be *Glareola p. pratincola.* However, we preferred to wait for a good photograph or specimen to confirm our identification in the field.

We learn that Mr. Nitin Jamdar came across this species in the Banni grasslands and in the vicinity of Chhari dhandh (*pers. comm.*). Besides this, on March 29, 1999 SNV counted 25 *G. pratincola* at Chhari dhandh.

Stuart Baker (1929) made the only mention of the collared pratincole in Kutch, but it is not clear on what authority or evidence he did so. Dr. Ferdinand Stoliczka was the first to collect bird specimens from Kutch. Apparently, Hume also collected information on the birds of this region, and also had specimens collected through his own sources. This was followed by a study of birds by one Hugh Palin, who prepared the first edition of THE BIRDS OF KUTCH in 1878, which was revised by Capt. C.D. Lester in 1904. None of these gentlemen, nor the Sálim Ali survey of 1943-44, make any mention of the occurrence of *G. pratincola.*

Stuart Baker also refers to the occurrence and breeding of *G. p. maldivarum* in Kutch and Sind. Taking into account all the references available to us, we feel there is now less likelihood of *maldivarum* occurring in Kutch. Roberts (1991) also mentions that there are no authentic recent sightings or records of this race in Pakistan. He further states that *G. pratincola* is met with mostly in lower Sind, particularly in Badin district along the border with India in the Great Rann of Kutch, and that too as a summer breeding visitor from East Africa. Gallager (1980) describes the collared pratincole as a passage migrant in Oman, the main passage being from August-October. That is after their breeding is over.

The water regime in the northwest part of the Great Rann (directly south of Badin in Sindh,

Pakistan) has undergone some changes over the years, owing to the release of water through a *nullah* to reduce the salinity of some land under the irrigation system. Because of this, some waterbirds (including both the greater and lesser flamingos) have extended their movements to that area. The collared pratincole may also move further southwards into Kutch from there.

The second noteworthy bird-record for Kutch was of a male blueheaded rock thrush *Monticola cinclorhynchus* (Vigors) seen by SNV near Dhonsa jheel (Bhuj environs) on January 27, 1985. The second sight record of this species in Kutch was by Fakirmahamad A. Turk, at his fruit farm at Dhrab village, west of Mundra, *c.* 45 km south of Bhuj, on March 9, 1999. He observed the bird till March 23, 1999; took coloured photographs (it was a male) and showed them to MKH.

This bird breeds along the Himalayan ranges and spends the winter in the Indian peninsula, but there are few records of its occurrence around Kutch. Though Dharmakumarsinhji lists it in his BIRDS OF SAURASHTRA, no specific reference is made therein to its presence in that region. Ripley (1982) mentions scarce cold weather records in southern Rajasthan and Gujarat ('including Kathiawar'). On the other hand, Roberts (1992) considers it a scarce winter visitor to Sindh. Thus, the blueheaded rock thrush is a vagrant in Kutch, not recorded before.

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12. OCCURRENCE OF THE CEYLON FROGMOUTH *BATRACHOSTOMUS MONILIGER* (FAMILY PODARGIDAE) IN RADHANAGARI WILDLIFE SANCTUARY, MAHARASHTRA

On November 21, 1998, I visited Radhanagari Wildlife Sanctuary, Kolhapur district, Maharashtra along with my friends. We were moving along one of the roads in the Dajipur region of the Sanctuary, leading to the core zone. The forest is of the west coast tropical evergreen and semi-evergreen type. At about 1120 hrs, we saw a large amount of bird droppings on the road, under a medium sized tree, so I thought that there may be a bird nest or roosting place. We started looking for the bird and located it soon, perched perfectly camouflaged on a small branch about 4 to 5 m above the ground. As it was disturbed, the bird flew off and sat on another branch of the same tree. I approached the bird and was able to take a few photographs from about 2 m away. As I moved closer, the bird started moving its head like an owlet, opened its large mouth, and then flew away into the nearby jungle.

On referring to literature, I realized that the bird was a Ceylon frogmouth (*Batrachostomus moniliger*).

I continued my observations and noticed a small round nest, placed in the fork of a small terminal branch. The cryptic colour of the nest was similar to that of the branch and a half grown nestling was present in the nest. When closely approached, the nestling started opening its mouth.

The Ceylon frogmouth (*Batrachostomus moniliger*) is one of the least known species of the evergreen forest biotope of the Western Ghats. The species was recorded earlier by Dr. Sálim Ali in Kerala (1935) who described it as a little known, nocturnal species, seldom seen during daytime. It was recorded again by Vijayan (1979) and Sugathan (1981) in Parambikulam Wildlife Sanctuary, Kannan (1994) recorded it for the first time from Tamil Nadu and Renee Borges (1986) recorded it from Kanara, North Karnataka. The present record extends its range further north.

The distributional range of the Ceylon frogmouth extends from the southern heavy rainfall tracts of the Western Ghats, from *c.* 15° N in North Kanara district, south to Trivandrum district, Kerala, (Ali 1970). According to Sugathan (1981), the distributional range of the Ceylon frogmouth is believed to be from the wet evergreen forests of Karnataka state in the Western Ghats to the southern tip of the country in Tamil Nadu, and Sri Lanka. The altitudinal limit of this bird is believed to be 1,200 m above msl.

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13. JUNGLE CROW *CORVUS MACRORHYNCHOS* AND ITS INGENUITY WITH DRY ROTI

On May 26, 1999 I was sitting near an artificial water hole in Kumbalgarh Wildlife Sanctuary, Rajasthan. During the afternoon, the movements of animals and birds had slackened. At 1210 hrs, a jungle crow (*Corvus macrorhynchos*) came and perched on the branch

of a babul tree (*Acacia nilotica*) near the water hole. The crow had a big piece of dry roti (bread) in its beak. After scanning the area, it flew near the water hole, submerged the roti in the water and started drinking water. After about four minutes, it removed the soft roti from the water and started eating it. When it had finished half of it, a blue bull (*Boselaphus tragocamelus*) approached it. The crow flew away, leaving part of its food near the water hole.

The next day, I was sitting near the same water hole when at 1220 hours, a jungle crow came with a piece of dry roti in its beak and perched on the same tree. After scanning the area, it landed near the water hole, submerged the dry roti in the water, drank water and removed the roti from the water after four minutes. However, this time the crow flew away from the water hole with the softened piece of roti in its beak.

I was surprised to see this ingenious behaviour of the crow.

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14. MORE EVIDENCE OF RED-VENTED BULBUL *PYCNONOTUS CAFER* FEEDING ON HOUSE GECKO *HEMIDACTYLUS FLAVIVIRIDIS*

The animal food of red-vented bulbul *Pycnonotus cafer* is recorded to be various large insects, including caterpillars, moths, ants and termites among others. In a rare case, a young common garden lizard *Calotes versicolor* was brought by the parent bird to feed its young, which resulted in the death of the young (Ali and Ripley 1987). Bharos (1999) recorded the attempted feeding by redvented bulbul on house gecko *Hemidactylus flaviviridis,* in which the bird killed the prey, but did not consume it.

On August 20, 1999 at about 1530 hrs, a red-vented bulbul landed on the large verandah of my house at Malda district, West Bengal, about 3 m away from me. It dropped a food item in the verandah, and started pecking at it. On taking a closer look, I found that it was a house gecko, about 12 cm in length. The lizard was almost intact except for the head, which was severed from the neck. Even after several pecks, the bird could not get a morsel. Then it started pulling out the viscera of the lizard through the severed neck by pushing its head deep into the abdomen. It fed on the viscera for the next 10 minutes. Unfortunately it was disturbed by my curiosity and flew off with the prey. I rushed to the verandah, but could not locate the prey or the bulbul again.

The northern house gecko is one of the commonest reptiles in West Bengal, and is found in almost every house. Its avian predators, as I have observed, include Oriental magpie-robin (*Copsychus saularis*) and the common myna (*Acridotheres tristis*). The latter was seen to capture a house gecko on April 4, 1998 near my house. But in this case, the gecko was lucky, it shed its tail by autotomy, to avoid the attention of the predator. The myna left the battleground carrying the tail of the prey, and settled on its nest in the ventilator of a nearby building.

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15. BROWN CRAKE *AMAURORNIS AKOOL* SYKES FEEDING ON THE EGGS OF THE LARGE PIED WAGTAIL *MOTACILLA MADERASPATENSIS* GMELIN

While I was studying the breeding biology of the large pied wagtail *Motacilla maderaspatensis* Gmelin on March 29, 1993, a pair of brown crakes (*Amaurornis akool*) raided the nest of the wagtail, located in a clump of polygonum (*Polygonum glabrum*) about 3 m from the banks of the river Mutha, Pune, Maharashtra. When I saw the crakes perched on a rocky islet, I hid in the green belt of plants, especially the evergreen karanj tree (*Pongamia glabra*). The breeding pair of wagtails immediately noticed the crakes, and without losing a second they started dive-bombing attacks. The crakes seemed to be indifferent, they did not move. One of the birds stretched its neck and uttered "a longdrawn vibrating whistle" (Ali and Ripley, HANDBOOK vol. 2: 168) This call can be described as "Tir r r r r r r r r ...". It was not only clearly audible to me, but anyone in the vicinity of the river could have easily heard it. This call served as a kind of signal to another bird, which was slightly larger. The larger crake dashed into the Polygonum bush and raided the nest. By pecking forcefully at the eggs, the crake broke them open and gulped down the white and the yolk as quickly as possible. The wagtails did not keep quiet while their nest was being robbed. They kept fluttering and hovering restlessly around the bush. The nest was completely destroyed within three minutes. The crakes flew off and disappeared into the bushes bordering the water. The wagtails chased them off frantically, but could not make physical contact. After having returned to the nest, the wagtails remained silent for about 5 minutes. The male perched on the polygonum bush made the first move, climbed down and walked up to the nest. Both the male and the female wagtail fed on the remains of the eggs. They also picked up the eggshells and disposed of them a few metres away from the nest.

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16. STATUS OF THE PURPLE-RUMPED SUNBIRD *NECTARINIA ZEYLONICA* IN GUJARAT STATE

The purple-rumped sunbird *Nectarinia zeylonica* (Linn.) is known to occur in peninsular India, south of a line from Nasik (northwest Maharashtra), Jabalpur, Madhya Pradesh (Ripley 1982, Ali and Ripley 1983, Grimmett *et al.* 1998). Ali (1955) during his avifaunal survey of Gujarat State had only a single sight record of this species from Pavagadh, Panchmahal district on October 30, 1944.

At least three other publications show that the species occurs definitely in the Rajpipla forest along the River Narmada (Monga and Naoroji 1983, Desai *et al.* 1993, Narve *et al.* 1997). In spite of this, only a single sighting is recorded by Grimmett *et al.* (1998).

We have been observing this species throughout the year at Vadodara (22° 00' N, 73° 16' E) and Anand (22° 32' N, 73° 00' E). It also breeds at both the places. One of us (Raju Vyas) located one nest on a bougainvillea plant during March-April 1986 at Sayajibaug Zoo Garden, Vadodara. Shri Fatehsinh Jasol photographed the nesting pair. At Anand, we observed a female feeding her two fledglings on June 30, 1995. We also observed breeding at Nadiad (22° 41' N, 72° 55' E) and Pariej (22° 33' N, 72° 38' E) in Kheda

district, Gujarat. At Surat (21° 12' N, 72° 52' E), it is a common breeding species (Bakul Trivedi, Snehal Patel, Mukesh Bhatt, *pers. comm.*) Sightings at Ahmedabad and Gandhinagar during 1998 by Shri Lavkumar Khacher and Shri Lalsinh Raol (Raol 1999) indicate its western distributional limit in Gujarat.

It can be concluded that the purple-rumped sunbird *Nectarinia zeylonica* is an uncommon resident of Gujarat State, and occurs in Surat district, Shoolpaneswar Wildlife Sanctuary (Bharuch district) as well as Vadodara, Kheda, Ahmedabad and Gandhinagar districts. Sálim Ali's remark (Ali 1955) that 'it seems curious that the species should be so rare in Gujarat' is clarified now.

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17. A SUPPLEMENTARY NOTE ON THE AVIFAUNA OF THE THAR DESERT (RAJASTHAN)

While birdwatching in the Thar desert between December 1985 and September 1999, I made extensive notes on the birds I encountered. It was, however, not until the publication of an annotated checklist of the birds of the Thar desert of Rajasthan (Rahmani 1997) which summarises the bird records of three surveys between February 1993 and May 1994, that I felt the need to publish my own sightings. Based on my experience in the area, I realised that the above mentioned checklist was not comprehensive. The purpose of this paper is to update Rahmani's list with additional records. Details of all records, both published and unpublished, are given for uncommon and rare species, while for those more frequent, only status and distribution are given.

Systematic list

Sixty-two species are listed below. The species' status in the Thar desert of Rajasthan is given in brackets as follows: R Resident; PR Presumably Resident; W Winter Visitor; S Summer Visitor; M Monsoon Visitor; PM Passage Migrant; V Vagrant; and (?) Status uncertain. Some of these are provisional, to be regarded as a general guide rather than a definitive statement. Common and scientific names are based on Manakadan and Pittie (2001).

Great crested grebe *Podiceps cristatus* (W): Recorded in the eastern part of the desert where there are suitable wetlands. A party of 22 was seen at Kharda, Pali district on January 5, 1989. Two were seen at Sardarsamand, Pali district on the same day.

Black-necked grebe *Podiceps nigricollis* (W): One individual was observed at Kharda, Pali district on January 5, 1989.

Great white pelican *Pelecanus onocrotalus* (W): Fifteen were observed at Kagoda, Barmer district on February 19, 1994. Twenty were recorded on January 31 and one on March 15, 1998 at Revasa, Sikar district. Quite regularly seen at Sardarsamand, Pali district.

Spot-billed pelican *Pelecanus philippensis* (W): Ten were recorded at Revasa, Sikar district on January 31, 1998 in the company of great white pelicans.

Black-crowned Night heron *Nycticorax nycticorax* (PR): More than 76, including 15 juveniles, were roosting at Revasa, Sikar district on January 31, 1998.

Lesser flamingo *Phoenicopterus minor* (W): Regular in winter at Sambhar Lake in varying numbers. About 18,500 were censused between December, 1995 and March, 1996 at Sambhar Lake (Sangha 1998). 90 were observed feeding at Kagoda, Barmer district on February 19, 1994. Three birds were recorded at Sardarsamand, Pali district on January 5, 1989. About 200 were recorded at Badopal near Suratgarh and two birds near Chhatargarh, Bikaner district during the winter of 1994 (R.G. Soni *pers. comm.*)

Marbled teal *Marmaronetta angustirostris* (W): An increasingly rare migrant. It was classified as a straggler and reported in Rajasthan from Bikaner and Bharatpur (Ali and Ripley 1987). There are only three recent records from the area under consideration. On February 14, 1994 three birds were recorded at RD 1333 on the Rajasthan Canal (Indira Gandhi Nahar). One on February 15, 1994, at RD 1440 on the Rajasthan Canal (Indira Gandhi Nahar) near Mohangarh, Jaisalmer district (Sangha 1994) and three from Pali, in February 1991 (Tiwari 1991).

Comb duck *Sarkidiornis melanotus* (R): Irregularly seen in the eastern part of the desert, local movements subject to water conditions. Two were recorded at Balsamand, Jodhpur district on January 15, 1989. Breeds at Nimaj, Pali district (Bhagirath Singh, *pers. comm.*). Listed as common by Hume (Whistler 1938).

Northern goshawk *Accipiter gentilis* (W): A rare migrant. First recorded from Rajasthan on January 3, 1990 at Gajner, Bikaner district, with an Indian sandgrouse *Pterocles exustus* in its claws. I have not seen it at Gajner on subsequent visits.

Eurasian Sparrow-hawk *Accipiter nisus* (W): Six in a loose flock were seen attacking greater short-toed larks *Calandrella brachydactyla* at Tal Chhapar, Churu district on February 12, 1994. Two were recorded on January 28, 1996 and three on February 1, 1998 at the same place. Hume considered the species as very rare (Whistler 1938).

Bonelli's eagle *Hieraaetus fasciatus* (R,W): Two were recorded at Fossil Park, Jaisalmer on January 12, 1986 (Phil Heath *pers. comm.*). One bird was observed drinking water at RD 845 on the Rajasthan Canal (Indira Gandhi Nahar) on February 13, 1994. Included by Hume and Whistler in their list (Whistler 1938).

Himalayan griffon *Gyps himalayensis* (W): Presumably a not so rare winter visitor, it seems to have been overlooked by bird watchers. One bird was seen near Mohangarh, Jaisalmer district on February 15, 1994.

Osprey *Pandion haliaetus* (W): Irregularly seen at Revasa, Sikar district as there has been no water for some years. Atleast one bird was sighted at Gajner, Bikaner, during December 1990 (R.G. Soni *pers. comm.*).

Merlin *Falco columbarius* (W): Rare winter visitor. Harsh Vardhan and I recorded one bird at Kanod, Jaisalmer district on February 15, 1994. The bird was hunting citrine wagtails *Motacilla citreola* near a shrinking waterbody. One bird was recorded on February 1, 1998 at Tal Chhapar, Churu district. A new record for Rajasthan.

Jungle bush-quail *Perdicula asiatica* (R):

Not uncommon in the eastern parts of the desert. Recorded from Revasa, Sikar district and Nimaj, Pali district.

Sarus crane ***Grus antigone*** (PR): Not uncommon in suitable areas of Pali and Jodhpur. Eight birds were recorded on March 28, 1993 at Sardarsamand, Pali district. A pair was seen and photographed at Navoda near Pachpadra, Barmer district in December 1998 (*Rajasthan Patrika*, December 6, 1998). Up to five birds were observed during December, 1998 at Nimaj, Pali district (Bhagirath Singh *pers. comm.*).

Pheasant-tailed jaçana ***Hydrophasianus chirurgus*** (PR): Likely to become common with the development of large seepage water bodies in the Rajasthan Canal area. At least four birds were sighted on a large wetland near RD 507 on October 2, 1998.

Beach stone plover ***Esacus magnirostris*** (R): Confined to the eastern parts of the desert. 28 were recorded at Sardarsamand, Pali district on March 28, 1993. Two at Revasa, Sikar district on June 2, 1998. Probably breeds at both sites. Two birds were recorded at Kuchaman, Nagaur district on June 9, 1993. Reported by Hume in 'suitable river beds in Jodhpur' (Whistler 1938).

Small pratincole ***Glareola lactea*** (?): Five were recorded at Kuchaman lake, Nagaur district on October 25, 1991.

Sociable lapwing ***Vanellus gregarius*** (W): An increasingly rare species, though Hume rated it as common (Whistler 1938). There are three records from Tal Chhapar, Churu district. One juvenile was recorded from Revasa, Sikar district (Sangha 2000). Two birds were recorded from Jaisalmer on January 18, 1999 (Ben King *pers. comm.*).

Northern lapwing ***Vanellus vanellus*** (W): Uncommon winter visitor. I recorded four birds on January 3, 1990 at Gajner, Bikaner district. One bird was recorded at Jod Beed, Bikaner in winter, 1993 (M. Kulshreshtha *pers. comm.*). Adam saw it twice at Kuchaman, Nagaur district (Whistler 1938).

Grey plover ***Pluvialis squatarola*** (PM): Two were recorded on February 29, 1997 and two on May 3, 1998 at Sambhar Lake. 'A specimen of this bird in full breeding plumage was shot' at Sambhar Lake (Adam 1874).

Pacific golden-plover ***Pluvialis fulva*** (PM) One individual in total breeding plumage was observed on April 3, 1997 at Sambhar Lake. Hume mentions one specimen collected from Pali (Whistler 1938).

Greater sand plover ***Charadrius leschenaultii*** (PM): Five birds were recorded in partial breeding plumage on September 10, 1998 at Sambhar Lake. Also recorded by Adam at Sambhar Lake (1874).

Eurasian curlew ***Numenius arquata*** (W, PM): Many records. Sightings of 18 birds on October 25, 1991 and one on March 27, 1993 at Kuchaman, Nagaur district; five seen on August 13, 1994; two on May 3, 1998 and six on August 7, 1998 at Sambhar Lake; one at Tal Chhapar, Churu on January 28, 1996, one at Deedwana, Nagaur on February 1, 1998. Hume rated the species as rare (Whistler 1938).

Terek sandpiper ***Xenus cinereus*** (PM): One bird was recorded at Sambhar Lake on September 10, 1998. Previously recorded at Sambhar Lake (Adam 1873).

Jack snipe ***Lymnocryptes minimus*** (W): One bird was recorded on February 1, 1998 at Kuchaman lake, Nagaur. Although listed by Hume (Whistler 1938), the species was possibly uncommon in the desert then as it is today.

Dunlin ***Calidris alpina*** (?) Per Undeland and I recorded 87 birds at Deedwana, Nagaur on February 1, 1998. Earlier at the same site, I recorded five birds on January 29, 1996. 13 were recorded on September 5, 1999 at Sambhar Lake. Four were in breeding plumage.

Curlew sandpiper ***Calidris ferruginea*** (?) Per Undeland and I recorded 8 birds at Deedwana, Nagaur on February 1, 1998. 25 birds were recorded at Sambhar Lake on September 25, 1998. Two of the birds were still in breeding

plumage. Six were recorded on September 5, 1999 at Sambhar Lake.

Red-necked phalarope *Phalaropus lobatus* (PM): 27 were foraging at Sambhar Lake on September 10, 1998. Two were recorded on a small pond close to the road near Revasa, Sikar district on September 12, 1998. Previously, specimens of this rare bird were obtained by Adam at Sambhar Lake (1874).

Herring gull *Larus argentatus (W, PM): Fairly common on Sambhar Lake.

Brown-headed gull *Larus brunnicephalus* (W, PM): Five were recorded at Gadisar, Jaisalmer on August 16, 1989. Fairly common on Sambhar Lake. Recorded by Whistler (1938).

Whiskered tern *Chlidonias hybridus* (W): Fairly common at Sambhar Lake and Revasa, Sikar district. Up to 250 were recorded at Sambhar Lake on September 23, 1996. Also at Badopal, Ganganagar district; Sardarsamand, Pali district and a wetland near RD 507 on the Rajasthan Canal (Indira Gandhi Nahar).

Gull-billed tern *Gelochelidon nilotica* (?): Seen all the year round in small flocks. Regular and fairly common at Sambhar Lake, Revasa and Deedwana. More than 100 birds were noted at Sambhar Lake on September 23, 1996. Five birds were hunting over a wheat field near Suratgarh, Ganganagar district on March 28, 1999. On May 23, 1999 three birds were observed hawking at Revasa, Sikar district.

Little tern *Sterna albifrons* (?): Summer visitor? Has been recorded at Revasa, Sikar district only in summer, where two pairs were recorded breeding in 1998 (Sangha and Kulshreshtha 1999). On May 23, 1999 I found one bird in breeding plumage at the same site.

Indian skimmer *Rhynchops albicollis* (V): There are two records from the desert area. The Zoological Survey of India (ZSI) collected one bird from Dangiwas, Jodhpur on August 10, 1966. One bird was recorded at Jod-Beed, Bikaner on March 28, 1993 (Sangha and Kulshreshtha 1998).

Painted sandgrouse *Pterocles indicus* (R): Fairly common in suitable areas of Sikar and Pali districts.

Asian Koel *Eudynamys scolopacea* (R): Not uncommon in Jodhpur city, perhaps increasing (Prakash 1998). One bird was heard calling at Gajner, Bikaner district on March 29, 1999 and one was seen at RD 840 on the Rajasthan Canal on October 1, 1998.

Sirkeer malkoha *Phaenicophaeus leschenaultii* (PR): I observed one individual near Sardarsamand, Pali district on January 5, 1989. 'Dr. King collected a specimen at Jodhpur' in the rains (Whistler 1938).

Barn owl *Tyto alba* (PR): Probably a scarce resident. There are four records from the Thar desert. One bird collided with an aircraft at Jodhpur (Satheesan and Grubh 1992). I found a dead bird on the road near Dungargarh, Churu district on March 3, 1993, and one in the gloaming on March 25, 1993 near Kheechan with Harsh Vardhan. Between Ratangarh and Dungargarh, a dead bird was recorded on February 24, 1996 (Rishad Naoroji *pers. comm.*).

Eurasian eagle-owl *Bubo bubo* (PR): Not common, but seems to be widespread. Not listed by Whistler (1938). One bird was observed hunting during the day at Tal Chhapar, Churu district on October 23, 1988. One was being mobbed by house crows *Corvus splendens* while drinking water at the Rajasthan Canal at RD 1214 on February 13, 1994. One was seen at Akal Fossil Park, Jaisalmer on October 3, 1993.

Desert finch-lark *Ammomanes deserti* (R): All records are from Jaisalmer, where it is fairly common in suitable habitats. Affects desolate, barren country in rocky, gravelly areas (*magra*). Usually found in pairs or small groups (Sangha and Kulshreshtha 1993). Not recorded by Hume and Whistler (Whistler 1938). Ali and Ripley (1987) recorded it only from Jammu.

Red-rumped swallow *Hirundo daurica* (M, W): Quite widespread during monsoon.

* Now split into *L. heuglini* and *L. cachinnans*

Small numbers are recorded in winter also. More common in the eastern parts of the desert.

Red-backed shrike *Lanius collurio* (PM): Uncommon passage migrant. A single male bird was recorded near Khuri, Jaisalmer district on September 10, 1993. One female with very prominent crescent marks on breast and flanks was recorded on October 3, 1993 at Barna village, in the Desert National Park, Jaisalmer (Sangha 1995).

Eurasian golden oriole *Oriolus oriolus* (S, V): The bird breeds in the canal areas of Ganganagar, Hanumangarh and Bikaner. R.G. Soni (1994) also recorded its breeding in the canal areas.

Marshall's iora *Aegithinia nigrolutea* (R): A breeding resident in Jodhpur, Pali and Sikar districts. Recorded by Hume from Jodhpur and by Adam from Kuchaman, Nagaur district (Whistler 1938).

Red-throated flycatcher *Ficedula parva* (W): Very common in plantations in the canal areas of Ganganagar, Bikaner and Jaisalmer (Sangha 1995). I have recorded it from suitable habitats in Sikar, Pali and Jodhpur districts; regularly from Bada Bag, Jaisalmer and Tal Chhapar, Churu. Specimens were collected from Hemavas Lake (Whistler 1938). Also included in Hume's Jodhpur State list (Whistler 1938).

Grey-headed flycatcher *Culicicapa ceylonenis* (W): A rare winter-migrant in the desert, but may increase in the canal areas. There is one record from Bajju, Bikaner district. It is not uncommon in wooded areas of Sikar district.

Blyth's reed-warbler *Acrocephalus dumetorum* (PM): Common in wooded areas and plantations during spring and autumn passage. It begins to arrive from mid-August and continues to do so till late October in small waves. Spring passage starts from end of March and continues to mid-May. Commonly seen in the plantation along the Rajasthan Canal (Indira Gandhi Nahar) and at Tal Chhapar, Churu and Revasa, Sikar district.

Plain leaf-warbler *Phylloscopus neglectus* (W): It winters mainly in Pakistan and its current status in India is uncertain (Grimmett, Inskipp and Inskipp 1998), but I found it quite regularly in the Fossil Park and the Desert National Park, Jaisalmer. A new record for India.

Olivaceous leaf-warbler *Phylloscopus griseolus* (?): All records are of autumn and spring passage. One bird was recorded from the Desert National Park, Jaisalmer on March 4, 1990 (Sangha 1995). One bird was recorded at Tal Chhapar, Churu district on September 30, 1998. Two birds were recorded near Bajju, Bikaner district on March 28, 1999. La Personne collected specimens during the surveys of Jodhpur State (Whistler 1938).

Greenish leaf-warbler *Phylloscopus trochiloides* (?): I observed one individual on September 30, 1998 at Tal Chhapar, Churu district, feeding in the trees near the rest house.

Blue rock-thrush *Monticola solitarius* (W): Uncommon. One individual was recorded at Gajner, Bikaner district on January 3, 1990 and one on December 19, 1998 at the same place. Hume reported it from the neighbourhood of Jodhpur (Whistler 1938).

Orange-headed thrush *Zoothera citrina* (W): A rare winter visitor, but may become more common in the canal area. One bird was recorded between Bajju and Amarpura on February 13, 1994. Possibly the first record for the Thar desert.

Pied tit *Parus nuchalis* (R): The species is found in thorn forests of Pali and Nagaur districts of the desert. J.K. Tiwari (1997) found it in Jalore also.

Paddyfield pipit *Anthus rufulus* (PR): Not uncommon from Pali and Sikar, the eastern districts of the desert, where it possibly breeds. Also recorded from Badopal, Ganganagar and Diyatra, Bikaner on March 27, 1999. Hume received no specimen from Jodhpur (Whistler 1938).

White-Eye *Zosterops palpebrosa* (R): Fairly common in the eastern parts of the desert. I have recorded the species breeding in Jodhpur and Sikar districts. Listed by Whistler (1938).

Blackheaded munia *Lonchura malacca* (?): One bird was recorded during monsoon, 1994 near Mohangarh, Jaisalmer district. (R.G. Soni *pers. comm.*)

Trumpeter finch *Bucanetes githagineus* (W): All my recent records are from Jaisalmer district, although Hume collected a male near Jodhpur (Whistler 1938). Not uncommon in Jaisalmer. Numbers vary from year to year. Usually in parties of 6-7 birds. However, on January 12, 1986 more than 400 birds were observed feeding in a field on the west side of the road leading to the Fossil Park, Jaisalmer (Phil Heath *pers. comm.*).

Common rosefinch *Carpodacus erythrinus* (?): Three birds were recorded in the plantation along the Rajasthan Canal (Indira Gandhi Nahar) near Bajju on March 23, 1999. One male was in breeding plumage. Rated as very rare by Adam (1873) at Sambhar Lake, who observed it on 'one or two occasions'.

Black-headed bunting *Emberiza melanocephala* (?): I recorded one male on March 27, 1993 with house sparrows at the Sudasri water-hole, Desert National Park. Hume found the species in 'simply millions' at Sojat, Pali district (Whistler 1938).

White-capped bunting *Emberiza stewarti* (W): I have recorded the species only from the eastern parts of the desert. Two males and one female were observed at Tal Chhapar, Churu district on February 1, 1998.

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18. STRANGE BEHAVIOUR IN THE RAT SNAKE *PTYAS MUCOSUS*, FAMILY COLUBRIDAE

We observed the following incident on July 20, 2001 between 1535 to 1550 hrs outside our office — the Conservation Education Centre, Bombay Natural History Society, Goregaon, Mumbai. An Oriental magpie-robin (*Copsychus saularis*) had laid four eggs in the battery box of a solar lamp post about three weeks earlier. The pale green eggs with reddish-brown spots were in a cup-shaped nest made of dry grass and twigs, resting in one corner of the battery box.

The eggs were intact and were being guarded regularly by the male and incubated by the female till the afternoon of July 20, 2001. We heard loud and harsh alarm calls by the robin at around 1525 hrs. Initially, we ignored it, as this behaviour is common for the robin when an intruder such as jungle babbler, squirrel or monitor lizard comes close to the nest.

This time, however, the calls were more intense and very loud. On looking at the lamp post, we saw a rat snake, *Ptyas mucosus* entering the battery box. As we went near to have a closer look, the snake slithered down, rushing towards some bushes to hide. We immediately opened the battery box to see the status of the nest and found that only one egg was left. We thought that the game was over, as three eggs had been eaten by the rat snake, but after an interval of 5 minutes, the robin started making similar alarm calls at the same place. We rushed back and were surprised to see the rat snake in the battery box again! Out of curiosity we opened the battery box, and found that the snake had regurgitated the eggshells.

The fourth egg was left untouched by the snake.

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19. FIRST RECORD OF BOULENGER'S TREE FROG *CHIRIXALUS VITTATUS* (ANURA: RHACOPHORIDAE) FROM MIZORAM, NORTHEAST INDIA

Chirixalus vittatus was described by Boulenger (1887) from Bhamo, Upper Burma as *Ixalus vittatus*. The species was reported from India by Romer (1949) who collected two gravid females on June 7, 1944 near Kohima (then in Assam State). Khare and Kiyasetuo (1986) subsequently reported the species from Kohima, Nagaland.

A single specimen was collected by Samraat Pawar and Sayantan Biswas, from a breeding site found near Ngengpui Wildlife Sanctuary, Lunglai district (Lai Autonomous District Council), southern Mizoram, during a survey conducted by them in 1998. The female was near a gelatinous foam-nest on *Saccharum* grass, about 3 m tall, nearly 50 m from the Forest Rest House of the Ngengpui Wildlife Sanctuary. They found the species to be locally common in

the area. A voucher specimen was collected (Regn No. ZSI A 9209, Zoological Survey of India, Kolkata). We compared our specimen with three non-type specimens from Nongkhor, Thailand to confirm our identification. This specimen therefore constitutes the first record of this species from Mizoram.

Measurements of the specimen: Snout-vent length: 29.78 mm, Head length: 7.08 mm, Head width: 8.06 mm, Snout length: 4.04 mm, Eye diameter: 4.12 mm, Tympanum diameter: 1.62 mm, Inter-orbital length: 4.08 mm; Inter-narial length: 2.71 mm, Tibia length: 13.84 mm.

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20. ON THE DISTRIBUTION OF *OREONECTES (INDOREONECTES) EVEZARDI* DAY AND *O. (I.) KERALENSIS* RITA, BANARESCU AND NALBANT (PISCES: BALITORIDAE)

The genus *Oreonectes* includes four subgenera comprising of ten species (Banarescu, and Nalbant 1995) distributed in Southeastern China, Northeast and Southeast Asia, and Western and Central India. The subgenus *Indoreonectes* Rita, Banarescu and Nalbant comprising of two species, namely *evezardi* Day (1878) and *keralensis* Rita, Banarescu and Nalbant (1978), is endemic to India. The species are characterized by the combination of the following characters: an elongate body, prolongation of the anterior nostrils into long nasal barbels, incomplete lateral line system, pelvic origin in advance of dorsal fin insertion, a dorsal and ventral adipose crest on the caudal peduncle and a rounded or straight caudal fin.

O. (I.) evezardi described from Poona, Maharashtra in the northern Western Ghats is now known to have a wider distribution in the Krishna and Godavari basins, and in Madhya Pradesh, in the Pachmarhi Hills of the Satpura Range. Chacko *et al.* (1954) reported its occurrence further south in the Mettur Dam of the Cauvery system in Tamil Nadu. Jayaram *et al.* (1982), while reporting on the fish fauna of the Cauvery system, remarked that they did not find the species, though reported earlier by Chacko *et al.* (*op. cit.*). Later, Jayaram (1999) and Menon (1999), have inadvertently omitted the Cauvery system from the distributional range of the species.

During routine faunistic surveys of conservation areas, one of us (SK) collected the species *evezardi* from the Biligiri Rangasamy Temple Wildlife Sanctuary (BRTWLS) in Karnataka from a tributary of the Cauvery river. Six specimens ranging in length from 25 mm to 45 mm SL, were collected from the following localities in BRTWLS, namely Girialla, Kabbanagatte and K. Gudi during February, 1999

and April, 2000. The specimens have been registered in the Reserve Collections of the Zoological Survey of India (Southern Regional Station). The present collection confirms the distribution of the species in the Cauvery river also. Incidentally, this is the first report of *evezardi* from Karnataka.

However, the specimens from BRTWLS exhibit some differences from the descriptions of Day (1875-1878), in having a more elongate and slender body and certain other differences in body proportions, as follows: Head length in Day's specimen is 5.5 times in TL, whereas in the present collections it is 4.68 - 4.95 times in TL. Body depth is 6 in Day's specimen (vs 7.3 - 8.1), caudal 5 times (vs 5.33 - 5.88) in TL. Pectoral fin is longer than head, reaching ¾ of the distance from pectoral to ventral fin origin, whereas in the specimens from BRTWLS the pectoral fins are shorter, reaching only a little more than half this distance. Though the proportion of eye in snout is given as 3 (also around 3 in the present collection), Day's figure shows a specimen with a smaller snout. The lateral line is said to be indistinct, while it is fairly prominent and extends to almost half the pectoral fin length in a smaller specimen and up to the pectoral tip in a larger specimen studied.

Hora and Law (1941) reported *evezardi* from Periyar River at Pambadumpara in Travancore Hills of Kerala and remarked on the variations exhibited in the colour pattern in this species. Subsequently, Rita *et al.* (1978) described *O. (I.) keralensis* from Periyar River at Pambadumpara, distinguishing the species from *evezardi* based on differences in colour pattern and relative lengths of nasal barbels. The nasal barbels are longer in *evezardi*, extending to middle of eye, whereas in *keralensis* it is said to be shorter reaching up to the anterior border of eye. The vertical bands on the body are broad and brown, and interrupted or incomplete, extending from the dorsal to the ventral side of the body in *evezardi,* whereas in *keralensis* these are narrow, dark and entire on the upper half of the body, and often split below the lateral line into streaks or spots. Rita *et al.* (*op. cit.*) remarked on the probability of Hora and Law's specimens being *keralensis*. Menon (1987) included Pamba drainage in the distribution of *keralensis,* based on his study of fish collections from Sabarigiri hills.

A study of loaches from the earlier collections, especially from Cardamom Hills in southern Western Ghats by Dr. G.U. Kurup in 1969, from Sabarigiri Hills by Dr. R.S. Pillai in 1981 and recently in 1999 from Periyar river by Mr. Chandran and other collections received for identification from Muvattupuzha and Santhamparai have all revealed the presence of *keralensis* and not *evezardi* in these areas. We reiterate the view of Rita *et al.* (1978) that the species present in the Travancore Hills is *keralensis*. Also, the specimens reported as *evezardi* from Periyar by Chacko (1948) before the description of *keralensis* and those reported by Zacharias *et al.* (1996), mostly based on Chacko (*op. cit.*), could also be *keralensis*. Biju *et al.* (2000) reported the occurrence of this species in Eravikulam National Park and Muvattupuzha river, from the cold waters at an altitude of 1,050 m in Muvattupuzha river and at a range of 1,600-2,200 m in Periyar river. From the above records, the present distributional range of *keralensis* is in the Periyar drainage, the Muvattupuzha river down to the Pamba river in the southern Western Ghats.

It can be concluded that *evezardi* has a wider distribution in the Northern and Central Western Ghats above the Palghat gap and in the Satpura Range, whereas its congener is restricted to the higher ranges of the southern Western Ghats below the Palghat gap.

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21. REDISCOVERY OF CRITICALLY ENDANGERED AIR BREATHING CATFISH *CLARIAS DAYI* HORA PISCES: CLARIDAE, AT MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU

During fieldwork at Mudumalai Wildlife Sanctuary, Tamil Nadu, as part of our research program on "Diversity, Ecological Structure and Conservation of Threatened fishes of the Nilgiri Biosphere Reserve (NBR)" we collected two specimens of air-breathing catfish *Clarias dayi* Hora, from Ombatta Swamp, a part of the Nilgiri Biosphere Reserve. The species is commonly called the Malabar Clariid and Magur and popularly known as Masarai in Tamil and Muzhi in Malayalam. It was originally described from Wynaad in Kerala. The present collection is a rediscovery after 64 years at a new locality.

Mudumalai Wildlife Sanctuary is situated in the Western Ghats of Nilgiri district, Tamil Nadu (11° 30'-11° 39' N; 76° 27-76° 43' E). Its total area is 321 sq. km, including 103 sq. km of the National Park. Ombatta Todu forms Ombatta swamp before it joins Bidar halla, a tributary of river Moyar, the main water source for Mudumalai Wildlife Sanctuary.

Earlier record

Clarias dussumieri (nec Valenciennes) Day (partim), 1877, Fishes of India: 484; Day (partim), 1889, Fauna of British India, Fishes 1: 117.

Clarias Dayi Hora, 1936, Rec. Indian Mus.

38(3): 350, fig. 4c (type locality: Wynaad, Kerala); Misra (partim), 1976 Fauna of India, Pisces (2nd edn) 3:129.

Clarias dussumieri dayi; Silas, 1952, Proc. nat. Inst. Sci. India.

Day (1877) collected a single specimen (7 inches long) of this species from Wynaad in Kerala. But he misidentified the specimen as *Clarias dussumieri* Valenciennes (Day 1877, 1889). Later Hora (1936) re-examined Day's collection and he described the same specimen as a new species *Clarias dayi* Hora.

According to the IUCN category, it is almost extinct, as it has not been reported anywhere in India since it was first described by Hora in 1936. Despite much work in Western Ghats of Nilgiri, Wynaad hills (Hora 1937, 1938, 1942; Silas 1951a, b; Rajan 1955; Jayaram 1981; Jayaram *et al.*, 1982; Rema Devi and Indra 1988; Easa and Basha 1995; Easa and Shaji 1997) it has not been reported again.

During this study, we did not find *Clarias dayi* Hora from the original type locality (Wynaad hills), but our present collection from Mudumalai Wildlife Sanctuary shows its presence and range extension in this sanctuary: a rediscovery after 64 years at a new locality.

Diagnosis

D. 70; P. 1/8; V. 1/5; A. 57; C. 16.

Body elongate, head depressed; mouth terminal; 8 barbels, short, not extending beyond eyes; nasal barbels shorter than half of head length; dorsal fin inserted behind pectoral fin tip; pectoral spine strong, serrated on its outer edge only; colour dark on back, lighter on side.

Distribution

Day collected a single specimen from Wynaad hills, Western Ghats of Kerala, India (Day 1877, 1889; Hora 1936; Misra 1976; Talwar and Jhingran 1991). The present collection indicates a range extension to Mudumalai Wildlife Sanctuary, Tamil Nadu.

Status

Critically endangered (Molur and Walker 1998).

Habitat

Inhabits fast flowing streams and palustrine wetlands.

Acknowledgments

We thank the Forest Department of Tamil Nadu for permission to work in the Mudumalai Wildlife Sanctuary and Council of Scientific & Industrial Research (CSIR) for financial support. We also thank Mr. Mathan for assistance in fieldwork.

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22. SOME INGENIOUS METHODS OF FISHING

During a visit to Karwar, Karnataka State, I came across a peculiar method of catching the common marine catfish *Arius dussumieri*. This method seems to be unique to the region and adopted by amateur fishermen after a good deal of practice. I have already described some methods of catching live marine fish for display in aquaria (*Hornbill 1986(4)*: 11-15, 36).

On May 27, 1990, amateur fishermen selected a tidal pool slightly high up on the beach. After heavy rains, at about 1630 hrs, I saw juveniles of *Arius* spp. coming in with the tide in huge numbers. Each fisherman targeted a fish and hit it repeatedly with a rubber slipper, so that the fish was temporarily stunned. It was then picked up carefully and placed in a tidal pool higher up on the beach, or merely put into a cloth bag. Sometimes the 'hit' resulted in the fish's dorsal spine getting stuck in the slipper and the fisherman carefully removed it and put it in the bag or tidal pool. The fish swam very fast, and sometimes the fisherman merely pushed it towards the shore to incapacitate it. This method of fishing was repeated until the incoming stock of fish was exhausted. There were scores of fishermen, and there was enough for everyone to take home, the average catch being 250 to 300 fish in an hour. This went on from 1645 to 1915 hrs, and it is surmised that each person got about 500 to 600 fish. I tried my hand at this type of fishing, but could not catch more than six fish over half an hour. Either my aim was bad, or the blow was not enough to stun the fish, I was able to bring in about a dozen fish alive. Another unique aspect of this method was that it was done only on one day: I was informed that this phenomenon occurs only once a year.

The other strange method of fishing involved the 'hook and drag' method. This was seen at the Girgaum Chowpatty Bay in South Mumbai, from the parapet wall at Marine Drive. Adult *Mugil* spp., *Lates calcarifer*, *Polynemus heptadactylus*, *Strongylura strongylura*, *Hemirhamphus* spp. were usually caught by this method, at high tide. The method involved whirling and releasing a non-baited line with a

single hook or multiple hooks. After the line hit the water, it was pulled up rapidly, which resulted in the body of the fish getting embedded on the hooks. The catch was then pulled up quickly.

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23. A NEW RECORD OF *BRACHYMERIA LASUS* WALKER (HYMENOPTERA: CHALCIDIDAE) ON *EUCHROMIA POLYMENA* LINNAEUS (LEPIDOPTERA: SYNTOMIDAE)

Euchromia polymena Linn. a diurnal moth is reportedly a pest of sweet potato in various parts of India (Lefroy 1909, Fletcher 1921, Ayyar 1940, Thomas and Jacob 1973, Hill 1994). According to its local abundance, it can become a serious pest defoliator (Hill 1994).

While studying the biology of this pest, I observed a chalcid parasitoid emerging from lepidopteran pupae collected in the field. From the 10 pupae collected, 4 female parasitoids emerged. They were later identified as *Brachymeria lasus* (Walker), a polyphagous pupal parasitoid.

Brachymeria lasus attacks a wide variety of agricultural pests. It is sometimes hyperparasitic. Narendran (1989) listed about 113 insects as hosts of the parasitic or hyperparasitic *B. lasus* in his monograph ORIENTAL CHALCIDIDAE. *Euchromia polymena* was not recorded as a host in this list. Thus, it is a new host record of the parasitoid.

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24. OVIPOSITION BEHAVIOUR OF *PALEXORISTA SOLENNIS* WALKER, DIPTERA: TACHINIDAE, A TACHINID PARASITOID OF TEAK DEFOLIATOR, *HYBLAEA PUERA* CRAMER

(*With one text-figure*)

Palexorista solennis (Diptera: Tachinidae) is one of the natural enemies of the teak defoliator, *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae), a destructive pest of teak (*Tectona*

grandis L.F.) (Nair *et al.* 1985, Nair 1988). The tachinids are dominant parasitoids (Beeson and Chatterjee 1939, Sudheendrakumar 1986) and have been recorded at various places (Beeson 1941, Gokulpur 1969, Walcher 1977, Nair *et al.* 1985, Sudheendrakumar 1986). In intensively managed commercial plantations, too, this parasitoid occurs as a major factor that reduces the defoliator population by 54.54% (Loganathan and David, unpublished). Understanding the steps in parasitism under natural conditions will be useful when these parasitoids are mass cultured in a laboratory. We, therefore, studied the oviposition behaviour of this potential parasitoid in an intensively managed teak plantation at Veeravanallur, Tamil Nadu in 1996 and the results are reported here.

The oviposition behaviour of female tachinids was studied before and after oviposition by closely watching thirty adult female parasitoids randomly selected in the plantation. Observations on host selection, number of attempts, duration of each attempt and mode of oviposition were noted.

The dipteran parasitoids use both the tarsi and proboscis while searching the host (Nettles 1982). In the first step of host-habitat selection, the female tachinid first randomly screens the leaf folds in which the second or third instar defoliator larvae take shelter (Fig.1). After locating a suitable leaf fold, the fly alights and walks about the leaf fold. It then drums the leaf fold with its fore and hind legs. According to Klomp and Teerink (1962), drumming sets up vibrations in the host, which the female parasitoid monitors, to determine the host size and in turn regulate the number of eggs deposited. In this case, drumming caused the larvae to peep out from the anterior or posterior end of the leaf fold. The fly stayed put, stretching and bending its oviscapt to lay the egg on the heads, legs or thoracic segments of the larvae

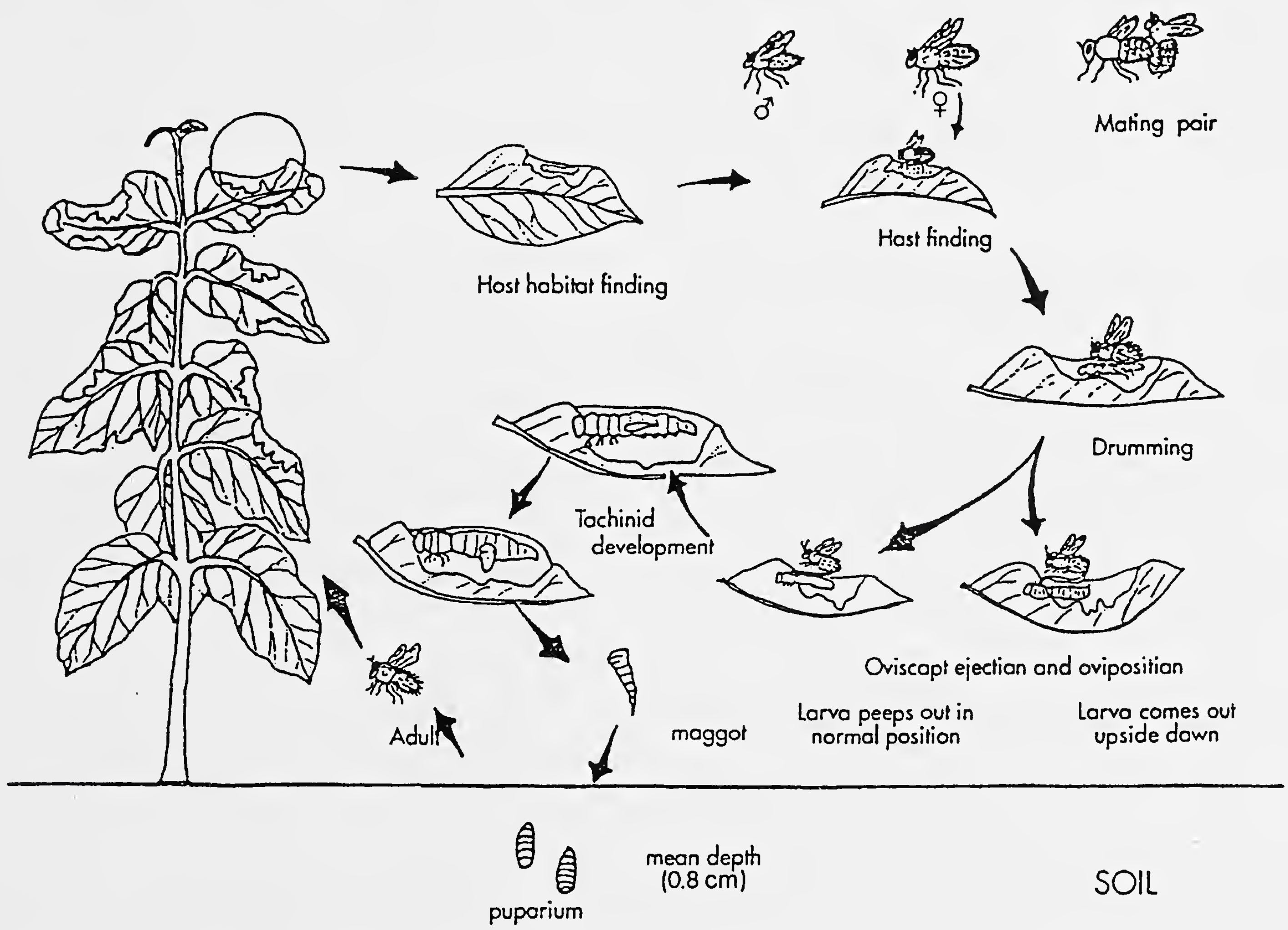

Fig. 1: Oviposition behaviour and development of *Palexorista solennis*

ventrally or dorsally, according to the position of the host larva. Cushman (1926) described several categories of ectoparasitoids based on the habit of placing eggs on the host. The location of egg on the host is often specific. *Nasonia vitripennis* (Walker), another tachinid parasitoid, deposits eggs on the ventral or dorsal area of the host (Wylie 1958). As the dipteran parasitoids generally lack a piercing ovipositor, their eggs are either attached to the substrate or to the host (Askew 1971). The fly often failed to deposit the egg as the larva would withdraw into the leaf fold, but it persisted until it succeeded. The fly made 1-8 attempts, the average being 4.6 (n=30). The fly spent 5.0 - 25.32 minutes in the process, the average being 15.54 minutes. After laying the egg, the tachinid flew away. Each host larva may bear one or two eggs of the tachinid owing to repeated oviposition by the same fly or another fly. On hatching, the tachinid maggot penetrates the body wall of the host defoliator larva, leaving a black lesion at the point of entry. The maggot developed in the thoracic region, moved to the abdomen as it matured. It finally escaped from the host by piercing the integument with its prothoracic hooks. It then drops to the soil for pupation, often burrowing 8 mm below the soil surface. Rarely does it pupate in the defoliator leaf fold. The adult fly emerges from the puparium in 6-7 days.

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25. FURTHER CONTRIBUTION ON THE DIPTERA (INSECTA) FAUNA OF ANDAMAN AND NICOBAR ISLANDS

An insular forest ecosystem along with tropical climate provides ideal niches for the rich insect fauna of the Andaman and Nicobar Islands. Schiner (1868) was the first to describe the dipteran fauna from the islands, and since then many workers have made substantial contributions in this field. The present paper is based on the collection of the Zoological Survey of India, Kolkata, as well as information on record. In this communication, the distributional records of the species have been considered only from Indian limits. The species with a single asterisk represent new records (12 species) from these Islands and with double asterisk denote new locality records (6 species) within the bay Islands.

Order: Diptera
Suborder: Nematocera
A) Family: Tipulidae

*1. ***Limonia (Euglochina) saltens*** (Doleschall)

Limnobia saltens Doleschall, 1857, *Nat. Tijd. Ned.-Indie.* 14: 390.

Material examined: 1M, Shompen village, Great Nicobar, 10.iv.1966, coll. A. Daniel and H.K. Bhowmick.

Distribution: Nicobar Islands and Kerala.

B) Family: Sciaridae

*2. ***Phorodonta exacta*** (Brunetti)

Sciara exacta Brunetti, 1912, *Fauna. Brit. India. Dipt. Nematocera 2: 132.*

Material examined: 2F, Havelock, South Andaman, 11.xi.1997, coll. S.K. Mondal & K.L. Bhatta.

Distribution: Andaman Is. and W. Bengal.

Suborder: Brachycera
C) Family: Bombyliidae

3. ***Ligyra flaviventris* (Doleschall)

Anthrax flaviventris Doleschall, 1857, *Nat. Tijd. Ned.- Indie.* 14: 400.

Material examined: 2F, 4 km from Hut Bay, Little Andaman, 17.i.1989; 22.i.1989; 1F, 31.i.1989, coll. A.N.T. Joseph.

Distribution: Andaman and Nicobar Islands and Kerala.

Suborder: Cyclorrhapha
D) Family: Syrphidae

*4. ***Dideopsis aegrotus*** (Fabricius)

Eristalis aegrota Fabricius, 1805, *Syst. Antliat*: 243.

Material examined: 1M, Wright Myo, South Andaman, 24.iii.1964, coll. B.S. Lamba.

Distribution: Andaman Islands, Meghalaya, Tripura and West Bengal.

5. ***Ischiodon scutellaris* (Fabricius)

Scaeva scutellaris Fabricius, 1805, *Syst. Antliat*: 252.

Material examined: 1M, Galathea Bay, Great Nicobar, 16.iii.1966, coll. A. Daniel & H.K. Bhowmick.

Distribution: Widely distributed in India including Andaman and Nicobar Islands.

6. ***Eristalinus aeneus* var. *taphicus*** (Wiedemann)

Eristalis taphicus Wiedemann, 1830, *Aussereurop. zweifl Insekt.* 2: 191.

Material examined: 1M, Casuarina Bay, Great Nicobar, 1966, coll. A. Daniel & H.K. Bhowmick.

Distribution: Andaman and Nicobar Islands, Maharashtra and Uttar Pradesh.

*7. ***Pseuderistalis fascipennis*** Thompson

Eristalis maculipennis de Meijere, 1908, *Tijd. Ent.* 51: 261.

Material examined: 1M, Manarghat, South Andaman, 1.iv.1964, coll. B.S. Lamba.

Distribution: Andaman Islands and Assam.

E) Family: Micropezidae

8. ***Mimegralla albitarsis splendens*** (Wiedemann)

Calobata splendens Wiedemann, 1830, *Aussereurop. zweifl Insekt.* 2: 539.

Material examined: 2F, Campbell Bay, Great Nicobar, 14.iii.1964; 1M, 16.iii.1964, coll. A. Daniel and H.K. Bhowmick.

Distribution: Andaman and Nicobar Islands, Delhi, Maharashtra and Uttar Pradesh.

F) Family: Tephritidae

9. ***Dacus (Zeugodacus) tau* (Walker)

Dasyneura tau Walker, 1849, *List Dipt. Colln Br. Mus.* 4: 1074.

Material examined: 1F, Great Nicobar, 17.iv.1964, coll. A. Daniel & H.K. Bhowmick.

Distribution: Widely distributed in India including Andaman and Nicobar Islands.

G) Family: Sepsidae

*10. ***Australosepsis niveipennis*** (Becker)

Sepsis niveipennis Becker, 1903, *Mitt. zool. Mus. Berl.* 2(3): 143.

Material examined: 5M, 2F, Nancowrie Bay, Great Nicobar, 13.v.1966, coll. A. Daniel and H.K. Bhowmick.

Distribution: Widely distributed in India including Andaman and Nicobar Islands.

H) Family: Muscidae

*11. ***Stomoxys calcitrans*** (Linnaeus)

Conops calcitrans Linnaeus, 1758, *Syst. Nat. Ed.* 10: 604.

Material examined: 1M, Wright Myo, South Andaman, 13.v.1988, coll. B. Mitra.

Distribution: Widely distributed in India including Andaman and Nicobar Islands.

I) Family: Calliphoridae

*12. ***Bengalia torosa*** (Wiedemann)

Musca jejuna Fabricius, 1794, *Ent. Syst.* 4: 312.

Musca torosa Wiedemann, 1819, *Zool. Mag.* (misidentification)

Material examined: 1M, Rajatgarh, Baratang, S. Andaman, 22.iii.1964, coll. B.S. Lamba.

Distribution: All the states of India including Andaman & Nicobar Islands.

*13. ***Bengalia varicolor*** (Fabricius)

Musca varicolor Fabricius, 1805, *Syst. Antliat.* 296.

Material examined: 2M, Rajatgarh, Baratang, S. Andaman, 22.iii.1964. coll. B.S. Lamba.

Distribution: Andaman & Nicobar Islands, Kerala and Tamil Nadu.

*14. ***Chrysomya megacephala*** (Fabricius)

Musca megacephala Fabricius, 1794, *Syst. Ent. 4*: 317.

Material examined: 1M, Delanipur, Port Blair, 7.vi.1982, coll. V. Arumugam.

Distribution: Common in all the states of India including Andaman and Nicobar Islands.

*15. ***Chrysomya rufifacies*** (Macquart)

Lucilia orientalis Macquart, 1842, *Mem. Soc. Sci. Agric. Lille,* 2: 303 (1843: 146)

Material examined: 1M, Rajatgarh, Baratang, S. Andaman, 22.iii.1964 coll. B.S. Lamba.

Distribution: Common in India including Andaman and Nicobar Islands.

J) Family: Sarcophagidae

16. ***Boettcherisca (s. str.) peregrina* (Robineau-Desvoidy)

Myophora peregrina Robineau-Desvoidy, 1830, *Mem. Pres. Acad. Sci. Inst. Fr.* (2): 356.

Material examined: 1M, Campbell Bay, Great Nicobar, 22.iii.1966, coll. A. Daniel and H.K. Bhowmick.

Distribution: Widely distributed in India including Andaman and Nicobar Islands.

17. ***Parasarcophaga* (*s. str.*) *albiceps* (Meigen)

Sarcophaga albiceps Meigen, 1826, *Syst. Beschr. europ. zweifl Insekt.* 5: 22.

Material examined: 1M, Horticulture Garden, Haddo, Port Blair, Andaman Island, 2.iii.1964, coll. B.S. Lamba; 1M, Netajinagar, Little Andaman, 18.i.1988 coll. A.N.T. Joseph; 1F, Galathea Bay, Great Nicobar, 28.iii.1966, coll. A. Daniel, & H.K. Bhowmick.

Distribution: Common in all parts of India including Andaman and Nicobar Islands.

18. ***Parasarcophaga* (*Liosarcophaga*) *dux* (Thomson)

Sarcophaga dux Thomson, 1868, *K. svenska Fregatten Eugenies Resa*, Dipt., 2: 534.

Material examined: 1M, Campbell Bay, 3.iii.1966, coll. A. Daniel and H.K. Bhowmick.

Distribution: Andaman and Nicobar Islands, Assam, Bihar, Kashmir, Maharashtra, Meghalaya, Orissa, Punjab, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

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26. SEASONAL OCCURRENCE OF *MELANITIS LEDA ISMENE* (CRAMER), SATYRIDAE: LEPIDOPTERA, WITH COMMENTS ON ITS DRY AND WET SEASON FORMS

(*With one text-figure*)

Melanitis leda ismene (Cramer) a butterfly of Family Satyridae (Order Lepidoptera) is widespread in West Africa, Southeast Asia and Australia (Bingham 1905, Talbot 1947, Grist and Lever 1969, Eliot 1992). It is the only nocturnal Rhopaloceran and is commonly found near fluorescent lights. The species is reported to be a pest of paddy (Ayyar 1961, Sajjan and Singh 1972) and has been collected from different parts of north India (Rose and Sharma 1998), but there is hardly any report on the biology of this species. Sajjan and Singh (1972) only mentioned the availability of its horned caterpillar on paddy in September-October, and the life span of the adults as 18-20 days.

This study was intended to observe the occurrence of wet and dry season forms and to examine the possible reasons for their appearance. The incidence of the dry and wet season forms in1998 was recorded.

The adults of *Melanitis leda ismene* were collected from the bushes and dry leaves under the forest trees, close to paddy fields around Chandigarh, where they hide during the day. A strip of forestland measuring 100 m x 40 m was selected for the collection of butterflies. Night

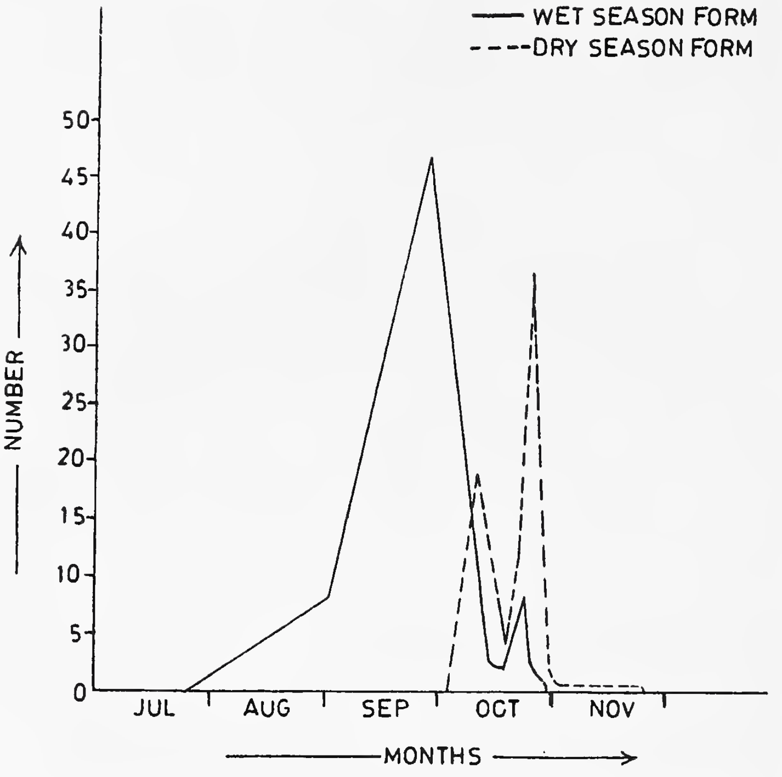

Fig. 1: Occurrence of dry and wet season forms of *Melanitis leda ismene* (Cramer) during 1998 in Chandigarh

collection was made from 10 fluorescent lights in the same area.

Regular surveys throughout 1998 showed that the adults appear during the last week of July in low numbers. During August, the butterflies were available in low numbers and about 4 to 7 adults were caught each day. All the adults caught during July and August were the wet season forms. The population of the wet season form started rising during the first week of September and reached a peak by end September. No dry season form was seen up to the end of September. In the beginning of October, the dry season form began to appear. To start with, the proportion of dry season form was low, but by the end of October, it was 12:1. The overall population reaches a maximum in October (Fig. 1), although the peak population of the wet season form was attained in September.

Clearly, the butterfly is active from July to October, when paddy is available. The butterfly appears to undergo diapause from the last week of November to last week of July. It is also evident that the butterfly undergoes more than two active generations, the life cycle being of 20-22 days.

Dry and wet season forms are seen in many Rhopalocera (Bingham 1905, Talbot 1947). These forms show marked differences in wing markings. Generally, wet season forms have ocelli on both surfaces of the wings and are known as ocellated forms. The dry season forms are devoid of such ocelli.

Melanitis leda ismene wet and dry season forms (Ph. 1-4) are recorded here. This species is a pest of paddy, but can also survive on other grasses. The caterpillars of the first generation, which feed on paddy leaves, mature into adults of the wet season form. With the ripening of the paddy leaves, some of the caterpillars of the subsequent generations start feeding on grasses, and mature into the dry season form. No satisfactory explanation has been offered for their appearance, and for their common incidence during certain periods. It appears that change of host is responsible for the appearance of dry season forms. This also explains the occurrence of both forms during the transition period. In most cases, the so called wet and dry season forms appear in the presence or absence of the monsoon, but this does not explain the morphological changes fully.

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27. MOLLUSCAN FAUNA AND ITS DISTRIBUTION IN THE WILD ASS SANCTUARY

Very little is known about minor animal forms, namely plankton, annelids, arthropods, molluscs, in almost all the Protected Areas in the country. No work has been conducted on the molluscan fauna of the Wild Ass Sanctuary (WAS), hence an attempt was made to study their diversity in the Sanctuary. From the management point of view, these animals are considered minor for the protected area, but they are found in a variety of habitats, show many adaptations and play a key role in maintenance of the habitat, which they share with more conspicuous wildlife, to which the majority of management practices are addressed in our country.

The Wild Ass Sanctuary is spread mainly over the Little Rann of Kutch, Gujarat State. It is situated between 23° 10' and 23° 45' N, and between 70° 45' and 71° 45' E. The Little Rann (4,953.59 sq. km) is a vast saline desert, typically arid and one of its kind in the world. It experiences a maximum temperature of 44 °C and a minimum of 5 °C, and receives 125 to 400 mm of rainfall. Three major rivers from the east, Banas, Saraswati and Rupen, inundate the Little Rann, where sea water also enters, and make a huge wetland. The Little Rann is just above sea level, and the Wild Ass Sanctuary is spread over five districts namely Rajkot, Surendranagar, Mehsana, Banaskantha and Kutch.

The study was conducted from December 1, 1997 to July 15, 1998. The material was collected in the waterbodies, muddy areas, creeks and a variety of habitats. The molluscs were narcotised by magnesium sulphate before preservation in 4% formaline or 70% alcohol. The samples were labeled and identified in the laboratory using standard references such as Hornell (1951), Kundu (1965), Menon *et al.* (1961) and Tonapi (1980). The Zoological Survey of India confirmed the identifications.

12 species (Table 1) representing 12 mollusc families were collected and identified; out of these 7 species belonged to 7 freshwater families and 5 to 5 brackish water families.

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TABLE 1
CHECKLIST OF MOLLUSCAN FAUNA AND ITS DISTRIBUTION IN THE WILD ASS SANCTUARY

S. No.	Species/Family	Distribution	Status
1	*Thiara* (*Melanoides*) *tuberculata* (Thiaridae)	Khareshwar Kund (Narali), Juni Anjiyasar gam talav, Chikhali gam talav.	C
2	*Ariophanta bajadera* (Ariophantidae)	Raghu ki gam talav, Boru talav (Rann kathe - near Khod), Mardak bet, Kuda gam talav, Naranpura gam talav, Chikhali gam talav, Nimaknagar gam talav, Garamadi Check Dam No. 1, Vajiyasar gam talav, Wasraj Solanki talav, (Wasaraj Solanki bet, slightly saline water), Juni Anjiyasar gam talav, Talav near Shiyal tekari (Amarapar), Sahebrana bet, Behal talav (Kajarada), Masali gam talav, Kalyanpura-Santalpur gam talav, Pipli gam talav.	C
3.	*Lymnaea* (*Pseudosuccinea*) *luteola* (Lymnaeidae)	Kalyanpura-Santalpur gam talav, Machchhu river (Near Maliya), Koparani Sim talav, Bandhparo talav (Visnagar), Mandraki sim talav.	C
4.	*Bellamya dissimilis* (Viviparidae)	Vajiyasar gam talav, Naranpura gam talav, Wasraj Solanki bet, Kali talav, Ranisar gam talav, Patasar talav (Khod), Bhanguria bet, Mardak bet, Sahabrana bet, Near Surajbari creek, Bhangarwa bet, Koridu talav (Navi Enjar), Chhanasara Dam (Chhanasara), Bhadari talav (Near Chikhali).	C
5.	*Zootecus insularis* (Subulinidae)	New Kuda gam talav, Shedwa bet, Mardak bet, Wasraj Solanki talav (bet), Jhilandhar bet, Juni Anjiyasar gam talav, Vajiyasar talav (Near Tundi tower), Pung bet, Khijadia bet, Jilkeshwar Kund (Jhilandhar bet), Jesra, Chhanasara Dam, Jagamal bet, Dhan bet, Shahensawali talav (Navi Anjiyasar), Nada bet, Kakindiya bet, Masali village Dhasi-1, Dugara village Dhasi, Bhangarawa bet, Thar (East from Gangasar talav-Palaswa), Boru village Dhasi-3, Masali village Dhasi-4, Naleshwar Temple (Jhilandhar bet), Rana bet, Gajetiya bet, Gaun bet, Ratadia bet, Sahebrana bet, Garamadi Village Dhasi, Nanda bet, Keshmara bet, Handi bet, Koparani (Near Camp Site), Ikadia grass plot, Khijariya bet, Akoria bet.	C
6.	*Indoplanorbis exustus* (Planorbidae)	Vajiyasar gam talav, Kali talav, Nimaknagar gam talav, Raghuki talav, Bodu talav (Khod), Patasar talav (Khod), Kuda gam talav, Tundi talav, Wasraj Solanki talav (Wasraj Solanki bet), Jilkeshwar Kund, (Jhilandhar bet), Dungariala talav (Vejalpar), Khijadia bet, Kumbharia gam talav, Sudamani talav (Rann kathe - Venasar), Koridu talav	C

TABLE 1 (CONTD.)
CHECKLIST OF MOLLUSCAN FAUNA AND ITS DISTRIBUTION IN THE WILD ASS SANCTUARY

S. No.	Species/Family	Distribution	Status
		(Nava Enjar), Lakhiar talav (Tikar), Mandraki sim talav, Mandraki gam talav, Venasar gam talav, Sukhpar Dam (Sukhpar), Varahi talav (Pung bet), Ajitgadh gam talav, Patasar talav (Khod), Chikhali gam talav, Behal talav (Rann-kathe- Kajarada), Savalasari talav (Near Vavania), Juni Anjiyasar gam talav, Navi Anjiyasar gam talav, Chovishi talav (Near Nanda), Bhagasar talav (Nava Ghatila), Pipli gam talav.	
7	*Lamellidens* sp. (Unionidae)	Jadeshar talav (Juna Ghatila).	R
8	*Cerithidea* (*Cerithideopsilla*) *cingulata* (Potamididae)	Nimaknagar, Kakindia bet, Nada bet, Bhanguria bet, Bandarvalo (Near Vavania), Shedwa bet, Tundi (near Kuda)	C
9	*Natica tigrina* (Naticidae)	Mardak bet.	R
10	*Thais lacera* (Muricidae)	Nimaknagar, Ikadia bet, Mardak bet, Andheriwan bet, Koparani Dhasi, Near Kuda.	C
11	*Anadara antiguata* (Arcidae)	Mardak bet, Surajbari creek, Nimaknagar.	C
12	*Meretrix* sp. (Veneridae)	Nimaknagar, Surajbari creek.	C

Abbreviations: C = Common, R = Rare (but may be common in other areas).

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28. FIRST RECORD OF *BOSMINA TRIPURAE* KORÍNEK *ET AL.*, 1999 (CRUSTACEA: CLADOCERA: BOSMINIDAE) FROM ASSAM

During a routine survey of water bodies of Assam State Zoo and Botanical Garden, Guwahati, Assam (26.10° N, 92.49° E) in 1997-1998, I came across several females of *Bosmina tripurae*, a Bosminid cladoceran. The species was described as new to science from Tamil Nadu in India (Korínek *et al.*, 1999). Based on the several females collected, a brief description of the species is given.

1999. *Bosmina tripurae* Korínek *et al.*, *Hydrobiologia*, 392: 241.

Female: Body size 0.45-0.64 mm in length, 0.16-0.24 mm in width. Shape almost oval. Head and eye large. Head with two frontal setae near rostrum. Antennules fused with rostrum, hardly reaching one-third the length of

the body. Antennae short, with antennal setation 0-0-1-3/1-1-3. Setae long. Posterodorsal corner of valve angular, posteroventral corner ends in an obliquely directed shell spine (mucro) and is about 2.1 mm long. Seta Kurzi lies just above the commencement of mucro. Anterior ventral valve has several plumose setae. Postabdomen short, quadrangular and ends in a long stout claw. Claw with three groups of spines, proximal pecten of 5-7 small spines, intermediate pecten of 6-8 stout, strong spines which increase in length distally, distal pecten of 10-12 spines continuing distally into minute spinules up to tip of claw.

The above description of *Bosmina tripurae* conforms well with the description of the species given by Korínek *et al.*, 1999, except that the present material is larger in size, and therefore varies in the number of spines in the claws. Saha and Bhattacharya (1991) recorded the genus from Tripura. Later, Korínek *et al.* (1999) studied the same material and treated it as a new species. However, Korínek *et al.* (loc. cit.) described the species from another conspecific population from Tamil Nadu. The species was found to occur in association with other cladocerans, namely *Daphnia* sp., *Ceriodaphnia* sp., *Moina* sp. and *Simocephalus* sp. The present report of the species thus extends its distribution.

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29. ON THE DAMAGE CAUSED TO THE GREEN MUSSEL *PERNA VIRIDIS* BY PINNOTHERID CRAB *PINNOTHERES CASTA* ANTONY & KUTTYAMMA, 1971 ALONG THE CALICUT COAST

The occurrence of pea crab *Pinnotheres* in oysters, clams, ascidians, holothurians and brachiopods has been reported from various parts of the world (Thompson 1835, Tesch 1918, Chhapgar 1955, Munsueti 1955, Yonge 1960 and Durve 1960). Silas and Alagarswami (1967) reviewed the pea-crabs (*Pinnotheres* spp.) and dealt with their systematics, ecology, biology and ethology. They also studied their occurrence and the effects of their infestation on *Meretrix casta* from the southwest coast of India. Antony and Kuttyamma (1971) described a new species of *Pinnotheres*, *P. casta* from *Meretrix casta*, which Silas and Alagarswami (1967) had left unnamed. Information on the pea crabs of India is rather meagre, but for the study of Silas and Alagarswami (1967).

Pea crabs are small, with carapace width ranging from 10-12 mm. The genus is recognized by the third pair of walking legs (WL) which are longer than other pairs, and dactyli of 3rd and 4th walking legs being larger than the 1st and 2nd

walking legs. *Pinnotheres casta* is distinguished from other species of the genus by its orbicular carapace.

Green mussels form an important subsidiary fishery along the west coast of Malabar, Kerala. About 5,400 metric tonnes of green mussels are harvested along the southwest coast annually. Pinnotherid infestation causes considerable loss to the mussel-catching fisherman.

Two hundred green mussels were collected from the mussel beds off West Hill beach, Kozhikode during January 1998. The mussels were opened, and the Pinnotherid crabs removed from the mantle cavity. The soft parts of the mussels were weighed to the nearest milligram and the damage caused by *Pinnotheres* was noted. The wet weight, dry weight, fat and protein contents of the infested and non-infested mussels were analysed and tabulated (Tables 1 & 2).

The average wet weight of the mussels infested by the crab was 6.20 g, whereas that of non-infested crabs was 11.18 g. The average dry weight of the infested mussel was 1.10 g, but that of non-infested was 2.77 g indicating a loss of about 55.45% of wet weight and 39.7% of dry weight (Table 1). The average protein content of infested and non-infested mussels was 56% and 64.5% respectively. The fat content was 8.66% in the non-infested mussels and 5.66% in the infested mussels. The incidence of infestation was found to be 11% during January 1998.

Silas and Alagarswami (1967) found that 48% of the clams (*Meretrix casta*) examined from Malpe (southwest coast of India) harbored the Pinnotherid crab; 83.1% of the infestation had one crab, 13.1% had two and 3.8% had 3 crabs. In this case, however, 90% of *Perna viridis* had only one crab and 10% had two crabs.

Silas and Alagarswami (1967) found that *Pinnotheres* were parasitic on *Meretrix casta*. Strauber (1942), and Christiansen & McDermitt (1958) recorded them on the American oyster *Ostrea virginica*. Our observation also confirms the parasitic nature of *Pinnotheres*, and *Perna viridis* was found to be a new host for *Pinnotheres casta*.

TABLE 1
WET WEIGHT AND DRY WEIGHT OF GREEN MUSSEL (*PERNA VIRIDIS*) INFESTED BY PINNOTHERID CRAB

	Wet Weight		Dry Weight	
	Infested (g)	Non-Infested (g)	Infested (g)	Non-Infested (g)
1.	6.05	13.00	1.005	
2.	5.90	12.80	0.10	
3.	7.30	10.55	1.32	3.05
4.	4.37	9.02	0.64	3.15
5.	8.67	12.95	1.60	2.57
6.	4.91	11.32	0.75	2.05
7.	7.00	14.17	1.05	4.00
8.	6.90	7.95	1.15	2.94
9.	9.40	8.87	1.90	3.42
10.	4.84		0.80	1.73
11.	6.50		1.32	2.02
12.	6.57		1.55	
13.	9.25		1.93	
14.	8.49		1.15	
15.	6.88		0.71	
16.	4.58		0.52	
17.	3.44		0.87	
18.	4.26		0.37	
19.	2.50			
	$\bar{X}$ 6.20	$\bar{X}$ 11.18	$\bar{X}$ 1.10	$\bar{X}$ 2.77

TABLE 2
PROTEIN AND FAT CONTENT OF INFESTED AND NON-INFESTED *PERNA VIRIDIS*

	Infested	Non infested
Protein %	56.00	66.50
	56.00	64.75
		62.00
	56.00	64.41
Fat	7.00	8.00
	5.00	9.00
	5.00	9.00
	5.00	8.66

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30. PRELIMINARY STUDIES ON SPIDER DIVERSITY AND THEIR WEBS IN SELECTED SACRED GROVES IN KERALA

Nature worship has been an ancient Indian tradition and all forms of life have been considered as sacred in Hindu scriptures. Certain landscapes or plants were also considered sacred. These sacred groves are pockets of climax vegetation preserved by religious sentiments. Such pockets are commonly referred to as "Kavu" in Malayalam, "Devarais" in Marathi, "Pavithravanam" or "Sindhra vanam" in Kannada and "Kadu" in Tamil (Induchoodan 1988). It is well known that the sacred trees such as banyan, peepal and other species of *Ficus* support a variety of life forms.

Spiders may be sedentary, social and could be cannibalistic. They are skilful hunters (Lococids), jumpers (Attids), excellent architects and specialized swimmers. All spiders are carnivorous. They are distributed extensively in the field, thick forest floors as well as in the human habitations and deserted buildings, under stones and logs and the tree trunks. Some of the spiders like *Araneus*, *Argiope*, *Leucauge* and *Gasteracantha* are orb web weavers. Members of Family Pholcidae make irregular webs, while those of Family Eresidae construct compact nests with many entrance holes. These nests are most commonly found in India on Acacia trees and shrubs. Some of the spiders prepare no webs or snares to catch their prey. Families Lycosidae, Gnaphosidae, Clubionidae, Sparassidae, Salticidae, Oxyopidae and Thomisidae are hunting or running spiders. The role of spiders in the biogenesis of different agro-ecosystems has been studied since 1943 (Kagan 1943, Whitcomb *et al.* 1963, Whitcomb and Bell 1964, Neyffler and Benz 1979, 1980, Doane and Dondale 1979, Doane *et al.* 1982). They have an important role in controlling pests. Crab spiders are of tremendous economic relevance in tropical countries as they capture and feed on cockroaches and domestic insect pests. *Heteropoda venatoria*, the giant crab spider could be effectively used to control cockroaches and other insect pests because of its preference for these creatures as prey.

Iringole Sacred Grove: The Iringole sacred grove is situated in Perumbavoor, Ernakulam district, Kerala. It is spread around about 10 ha and lies between 10° 10' N and 76° 30' E. The grove is more or less at sea level. The

forest type is Southern Tropical West Coast Evergreen (Champion and Seth 1968). It has a luxuriant growth of trees, shrubs and herbs. The dominant tree species are *Hopea parviflora*, *Hopea ponga*, *Vateria indica*, *Holigarna arnottiana*, *Polyalthia fragrans*, *Mesua nagassarium*, *Aporusa lindleyana*, *Casearia esculenta*, *Cinnamomum malabathrum*, *Mallotus philippensis*, *Myristica malabarica*.

Mookuthala Sacred Grove: Mookuthala sacred grove (*c.* 3 ha) is situated in the Nannamukku Village of Malapuram district, Kerala and lies between 10° 49'-11° 40' N and 75° 50'-76° 35' E.

The Mookuthala forest sacred grove is a lowland, Southern Tropical West Coast Evergreen type (Champion and Seth 1968). The dominant tree species in this locality is *Poeciloneuron indicum* (Butham Kolli). *Aglaia elaegnoidea*, *Caryota urens* and *Ervatamia heyneana* are also abundant.

Sangukulangara Sacred Grove: Sangukulangara sacred grove (*c.* 3 ha) is situated in Srinarayanapuram near Kodungallur of Thrissur district, Kerala between 10° 43' N and 76° 53' E and can be classified as Southern Tropical West Coast Evergreen (Champion and Seth 1968). The vegetation mainly consists of *Hopea ponga*, *Memecylon umbellatum*, *Artocarpus hirsutus*, *Syzygium caryophyllatum*, *Garcinia gummi-gutta*, *and Xanthophyllum flavescens*.

The study was conducted in three selected sacred groves in Kerala from December 1991 to March 1998 following quadrate method (Ludwig and Reynolds 1988). Plots of 10 m x 10 m were laid randomly in different locations in the grove. Each grove was surveyed in the morning (0730-0930 hrs), afternoon (1200-1400 hrs) and evening (1600-1800 hrs). The spiders were identified along with the type of web, number of radials, number of rings, web height from ground level and the plant species used for anchoring the web (Table 1).

The spiders collected were preserved and later identified with the help of a standard key (Pocock 1900; Subramanyam 1968a, b; Tikader 1976, 1980, 1982; Tikader and Biswas 1981; Vijayalakshmi and Ahimaz 1993) and an ordinary hand lens. Quantitative information like richness, diversity and evenness of distribution were found using SPDIVERS.BAS in STATECOL (Ludwig and Reynolds 1988).

Fourteen species of spiders were recorded (Table 2), all of which are widely distributed in India. Mookuthala sacred grove had the highest number of spider species (8) followed by Sangukulangara (7) and Iringole (6).

Iringole Sacred Groves: A total of 152 spiders were recorded during the study period in Iringole. *Argiope anasuja* (35.52%) was the commonest in the area followed by *Araneus nympha* (22.36%), *Hippasa agelenoides* (17.10%), *Gasteracantha geminata* (15.78%), *Cyrtophora moluccensis* (8.55%) and *Tegenaria* sp. (0.65%).

Mookuthala Sacred Grove: A total of 275 spiders were recorded during the study period in Mookuthala. *Argiope anasuja* (36.00%) was found to dominate in the area followed by *Araneus nympha* (20.00%), *Hippasa agelenoides* (11.27%), *Tegenaria* sp. (10.54%), *Gasteracantha geminata* (8.72%), *Crossopriza lyoni* (8.72%), *Lycosa quadrifer* (4.36%) and *Poecilotheria rufilata* (0.36%).

Sangukulangara Sacred Grove: Out of the 472 spiders recorded in Sangukulangara, the highest percentage recorded was of *Stegodyphus sarasinorum* (44.06%) followed by *Argiope anasuja* (21.9%), *Hersilia savignyi* (13.13%),

TABLE 1
DETAILS OF SAMPLING EFFORT

Name of grove	No. of days spent	No. of plots	Total No. of spiders
Iringole	9	270	152
Mookuthala	8	240	275
Sangukulangara	8	240	472

TABLE 2
SPIDER SPECIES RECORDED
IN THE THREE SACRED GROVES

Family and Species name	SG1	SG2	SG3
I. **Araneidae**			
Argiope anasuja Thorell	54	99	102
Gasteracantha geminata (Fabricius)	24	24	47
Nephila maculata (Fabricius)	-	-	24
Cyrtophora moluccensis (Doleschal)	13	-	-
Araneus nympha Simon	34	55	-
II. **Hersilidae**			
Hersilia savignyi Lucas	-	-	62
III. **Oxyopidae**			
Oxyopes rufisternis Pocock	-	-	11
IV. **Lycosidae**			
Lycosa quadrifer Gravely	-	12	-
Hippasa agelenoides (Simon)	26	31	-
V. **Pholcidae**			
Crossopriza lyoni Blackwall	-	24	-
VI. **Psechridae**			
Fecenia travancoria Pocock	-	-	18
VII. **Eresidae**			
Stegodyphus sarasinorum Karsch	-	-	208
VIII. **Theraphosidae**			
Poecilotheria rufilata Pocock	-	1	-
IX. **Agelenidae**			
Tegenaria sp.	1	29	-
Total	152	275	472

SG1 = Iringole, SG2 = Mookuthala, SG3 Sangukulangara, - = absent

TABLE 3
RICHNESS INDICES OF SPIDERS IN THREE DIFFERENT SACRED GROVES

Indices	SG1	SG2	SG3
N_0	6.00	8.00	7.00
R1	0.99	1.24	1.97
R2	0.49	0.48	0.32

SG1 = Iringole, SG2 = Mookuthala, SG3 Sangukulangara, N_0 = No. of species, R1 = Margalef index, R2 = Menhinck index

Gasteracantha geminata (9.9%), *Nephila maculata* (5.08%), *Fecenia travancoria* (3.81%), and *Oxyopes rufisternis* (2.33%).

Richness Indices: The richness indices of the spider community in three different sacred groves are presented Table 3. The R1 value is high in Sangukulangara sacred grove (R1 = 1.97) followed by the Mookuthala sacred grove (R1 = 1.24), indicating the richness of the area.

Evenness Indices: To quantify the evenness component of the diversity, five indices were used. E1, E2 and E3 are considered here for interpretation because these values are sensitive to the number of species in the sample. The evenness was observed to be more in Iringole and less in Mookuthala sacred grove (Table 4). The E4 and E5 values are unaffected by the richness (Ludwig and Reynolds 1988).

TABLE 4
EVENNESS INDICES OF SPIDERS
IN THREE DIFFERENT SACRED GROVES

Indices	SG1	SG2	SG3
E1	0.85	0.84	0.79
E2	0.77	0.72	0.67
E3	0.73	0.68	0.62
E4	0.92	0.83	0.78
E5	0.90	0.79	0.72

SG1 = Iringole, SG2 = Mookuthala, SG3 = Sangukulangara, E1-E5 = Evenness indices proposed by various authors (Ludwig and Reynolds 1988)

Diversity Indices: Simpson's index (l) are highest in Sangukulangara, followed by Iringole and Mookuthala. Shannon Wiener index H' is the most widely used index in community ecology. The H' value increases when all the species are represented by same numbers of individuals or in other way with even distribution of abundance's. N1 value is high for Mookuthala (5.78) and shows an even distribution of abundance when compared with Iringole and Sangukulangara (Table 5).

TABLE 5
DIVERSITY INDICES OF SPIDERS
IN THREE DIFFERENT SACRED GROVES

Indices	SG1	SG2	SG3
λ	0.23	0.20	0.27
H'	1.53	1.75	1.55
N1	4.66	5.78	4.72
N2	4.29	4.81	3.68

SG1 = Iringole, SG2 = Mookuthala, SG3 Sangukulangara, N1 and N2 = Hill's diversity numbers

Abundance: All the spider species studied show uniform abundance in all the sacred groves (Table 6). *Stegodyphus sarasinorum*, found in social webs, was found only in the Sangukulangara sacred grove, hence the high abundance factor.

The present study on spiders indicates highest number of species in Mookuthala followed by Sangukulangara. Iringole, the largest of the sacred groves studied had only six species. The study does not indicate much variation in the number of species observed. However, it does indicate a uniform abundance in all the groves. The diversity indices do not show much difference between sacred groves.

Among the recorded species, *Argiope anasuja* and *Gasteracantha geminata* were common in all the areas. Five species namely *Nephila maculata*, *Oxyopes rufisternis*, *Hersilia savignyi*, *Fecenia travancoria* and *Stegodyphus sarasinorum* were confined only to Sangukulangara sacred grove. Three species namely *Lycosa quadrifer*, *Poecilotheria rufilata*, *Crossopriza lyoni* were recorded only from Mookuthala sacred grove and *Cyrtophora moluccensis* was observed only in Iringole.

Occurrence of various species in sacred groves seems to be correlated with the vegetation type and biotic interference. *Nephila maculata*, the spider with large sized web was recorded only from the least disturbed, but thick grove in Sangukulangara. *Lycosa quadrifer* and *Poecilotheria rufilata* are ground dwelling spiders. *Hippasa agelenoides* and *Tegenaria* sp. are seen mostly on grasses. These four species were found mostly in Mookuthala followed by Iringole, the groves having grassy ground floor. The tree dwellers are mostly seen in Sangukulangara and Mookuthala where most trees are undisturbed. Further, the presence of bonnet macaque, which move around a lot in Iringole could have also been one of the reasons for the absence of large web making species such as *Nephila maculata*.

TABLE 6

ABUNDANCE OF SPIDER SPECIES IN THREE SACRED GROVES

		Abundance (m^2)		
Sl. No.	Species name	SG1	SG2	SG3
1	*Argiope anasuja*	.01	.01	.01
2	*Gasteracantha geminata*	.01	.01	.01
3	*Nephila maculata*	-	-	.01
4	*Cyrtophora moluccensis*	.01	-	-
5	*Araneus nympha*	.01	.01	-
6	*Hersilia savignyi*	-	-	.01
7	*Oxyopes rufisternis*	-	-	.01
8	*Lycosa quadrifer*	-	.01	-
9	*Hippasa agelenoides*	.01	.01	-
10	*Crossopriza lyoni*	-	.01	-
11	*Fecenia travancoria*	-	-	.01
12	*Stegodyphus sarasinorum*	-	-	12
13	*Poecilotheria rufilata*	-	.01	-
14	*Tegenaria*	.01	.01	-

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31. NOTES ON *CLEMATIS BOURDILLONII* DUNN (FAMILY RANUNCULACEAE)

(*With one plate*)

Clematis bourdillonii was described in 1914 by S.T. Dunn, on the basis of two collections 554 & 860 of T.F. Bourdillon from Merchiston Estate, Travancore (presently in Kerala). He chose the name as a tribute to the memory of T.F. Bourdillon, who botanised Travancore during 1872-1908. The species is distinguished by its larger flowers and prolonged anther connective from *C. gouriana* Roxb. and by the entire leaf margin, without undulations, and glabrous plants (except flowers) from *C. hedysarifolia* DC. This species is endemic to the southern Western Ghats, and is known only by the type collections from Merchiston Estate.

In FLORA OF THIRUVANANTHAPURAM, Mohanan and Henry (1994) state that "This rare species could not be collected and is not represented in MH". They examined both the specimens (syntypes) present at University College herbarium, Thiruvananthapuram, and Bourdillon 860 was designated as the lectotype. Recently, I located one of the type specimens of *C. bourdillonii* Dunn, 554 of T.F. Bourdillon and a photo of Bourdillon 860 in the Madras Herbarium, Coimbatore.

The publication on the rediscovery of *Clematis bourdillonii* Dunn from Kodaikanal Hills by Ramachandran (1998) prompted me to examine the collection from Mathikettan shola, 9.xii.1994, V.S. Ramachandran 10283 Madras Herbarium (MH). The specimens from Mathikettan shola (Ramachandran 10283, MH), characterised by ternate leaves with long,

Murthy, G.V.S.: *Clematis bourdillonii* PLATE 1

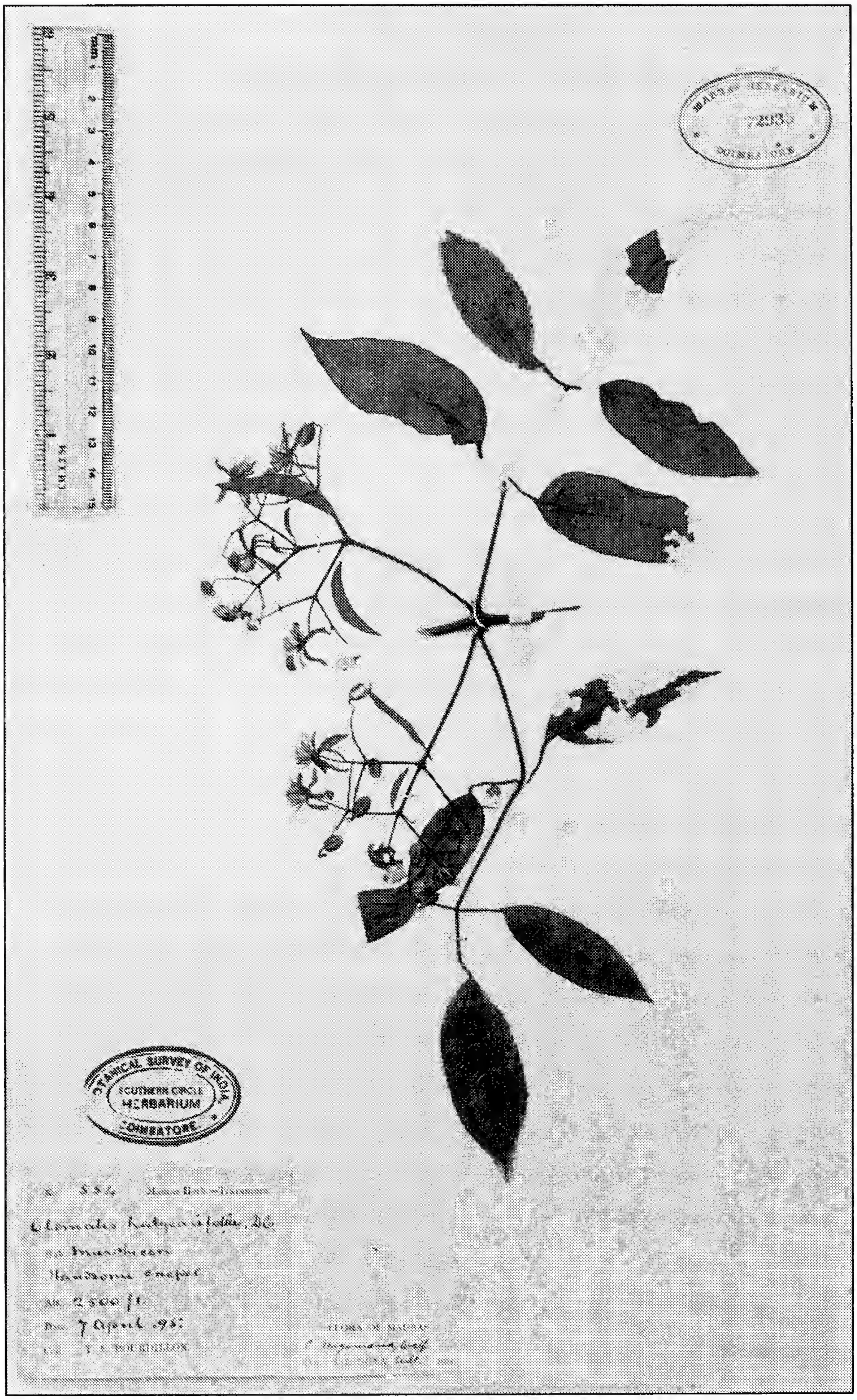

Fig. 1: *Clematis bourdillonii*, Type 554

A COMPARISON OF *CLEMATIS BOURDILLONII* WITH SOME ALLIED SPECIES

	C. bourdillonii	*C. gouriana*	*C. hedysarifolia*	*C. munroana*
Habit	Climber	Climber	Climber	Climber
Stem	Glabrous purplish	Hairy brown	Hairy brown	Glabrous brown
Leaves	Pinnate leaflets oblong-elliptic entire, 3-nerves raised both sides base acute	1-2-ternate-pinnate leaflets entire/dentate, base cordate	Ternate/pinnate dentate 5-nerved, veins raised lower base cordate	Ternate, entire 5-nerves raised below, veins obscure, base acute
Petiole	4-5 cm	2-6 cm	7-8 cm twisting	12-14 cm
Petiole	1-2 cm	1-2 cm	1-2 cm	4-5 cm cirrose
Inflorescence	Cymosely flowered panicle (13 fls.), pedicel 1.6 cm	Panicle, fls. crowded pedicel 1.5 cm	Lower paniculate higher 3-flowered pedicel 1 cm	1-5 flowered, pedicels 10 cm long
Flowers	Greenish-white buds elliptic	Greenish-white buds obovate	Greenish-yellow buds globose /ovate	Maroon buds ovate
Sepals	Oblong, pubescent outside, margins tomentose	Obovate, white pubescent in and out	Ovate, densely hairy outside	Oblong, velvety tomentose outside
Stamen	Connective produced; filaments flat, anthers lateral	Connective not produced: filament linear, anthers terminal	connective produced; filaments flat, anthers lateral	connective produced; filaments linear, anthers lateral

cirriform petiolules and 1-3 maroon flowers with long pedicels, belong to *Clematis munroana* Wight, a well marked species, which has been misidentified by Ramachandran and described as a different species. A comparison of these specimens with the Bourdillon specimen 554 in MH confirmed that they are not *C. bourdillonii.* Similarly, I am sceptical about the identity of the collection Sobha 6223 (KUBOT) and the report of chromosome number n = 24 for *C. bourdillonii* by Sobha and Ramachandran (1980), since the specimens are not traceable (*pers. comm.*).

The description of *Clematis bourdillonii* Dunn in Indian floras is not elaborate (Gamble 1915, Rau 1993, Mohanan and Henry 1994). Further, Rau (1993) described the plants as glabrous or sparsely hairy, leaflets entire or sometimes coarsely toothed (perhaps from key to species from Gamble l.c.), whereas the protologue says that the plants are glabrous (except flowers) and leaflets 6-9 cm, entire (Dunn 1914).

In view of the above findings, a detailed description of *C. bourdillonii* Dunn with a figure and comparative account with allied species is provided.

Clematis bourdillonii Dunn, Bull. Misc. Inform.: 181, 1914; in Gamble, Fl. Pres. Madras 1: 3. 1915; Rau in Fl. India 1: 59. 1993; Mohanan & Henry, Fl. Thiruvananthapuram: 40. 1994. (Plate 1, Fig. 1).

Handsome climber, branches furrowed, glabrous (except flowers), glossy, dark purplish. Leaves opposite, pinnate (1-2 ternate by Dunn), leaflets 5, oblong or elliptical, 6-9 x 1.6-2.5 cm, tip and base acute, entire and plain, nerves 3-5, raised on both sides, reticulate in full length; petiole 4.5-5.5 cm, stipular marks absent; petiolules 1-2 cm. inflorescence axillary or terminal, cymosely flowered panicle (13-flowered); peduncle 6-7 cm, glabrous. Flower buds 7-10 mm long, oblong-elliptic; flowers *c.* 2 cm across; pedicels 1.5-1.7 cm. Sepals 4, greenish, oblong, 10-12 x 2-3 mm, ultimately reflexed, glabrous inside, villous outside, margins tomentose. Stamens *c.* 20, 6 mm long, equal to styles or slightly longer; filaments glabrous, flat,

2-3 x 1 mm, connective produced beyond anther lobes, 1-1.5 mm long; anthers 2-3 mm, Carpels 7-10, hairy, styles hairy. Achenes not seen.

Fl.: April-May.

Ecology: Medium elevations, 753.5 m., secondary forests.

Distribution: INDIA: Endemic to southern Western Ghats in Kerala.

Specimens examined: Travancore, Merchiston Estate, 7.iv.1895, T.F. Bourdillon 554 (MH) (Bourdillon identified as *C. hedysarifolia* DC., Dunn (1914) annotated as *C. meyeriana* Walp. Cult. ?); *T.F. Bourdillon* 860 (MH, photo) (Bourdillon identified as *C. hedysarifolia* DC., Dunn (1914) annotated as *C. bourdillonii*); Merchiston Estate, 9.iv.1895, *T.F. Bourdillon* 554 (K) (identified as *C. gouriana* Roxb., Dunn annotated as *C. bourdillonii* Kew Bull. 181, 1914).

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32. PRESENCE OF *COMMIPHORA GILEADENSE*, FAMILY BURSERACEAE, IN RAJASTHAN

(*With one text-figure*)

On October 15, 1999, while I was on a biodiversity survey in and around the Sitamata Wildlife Sanctuary, at the border of Udaipur and Chittorgarh districts in southern Rajasthan, I noticed many plants of *Commiphora gileadense* near Kedaria Village (Udaipur district) growing naturally. This area falls under the jurisdiction of Aravalli Afforestation Project Range Bhinder of Udaipur (North) Forest Division. Local farmers told me that this species was present in the forest area and beeds (patches of private forests) of surrounding villages also. *C. gileadense* is a bushy plant, having trifoliate leaves on slender petioles. Lateral leaflets are of small size, while terminal leaflets are generally large in most of the observed plants. The leaves of *C. wightii*, which is a rather common species in Rajasthan, do not have slender petioles (Fig. 1).

According to Brandis (1972) and Talbot (1976), *C. gileadense* is an indigenous species confined to the east side of the Nilgiris and dry parts of Sri Lanka. It is also cultivated as a hedge plant all over South India. It is reported from Poona and Khandesh area of Maharashtra (Almeida 1996).

This species is not included in the various Floras of Rajasthan (Bhandari 1990, Sharma and Tiagi 1979, Shetty and Pandey 1983, Shetty and

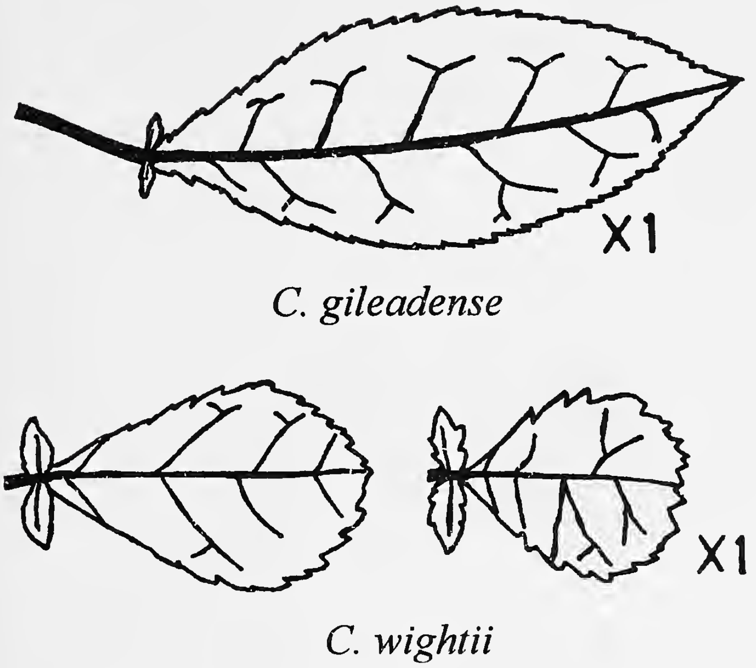

Fig 1: Leaves of *C. gileadense* and *C. wightii*

Singh 1987, 1991, 1993 and Singh 1983), hence this sighting is of special interest.

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33. *VENTILAGO BOMBAIENSIS* DALZ., RHAMNACEAE — A NEW DISTRIBUTIONAL RECORD FOR TAMIL NADU

(*With one text figure*)

In the course of floristic exploration of Tirunelveli hills of Southern Western Ghats, the authors collected an interesting specimen of the genus *Ventilago* Gaertn. (Rhamnaceae). Critical analysis and perusal of literature confirmed it as *Ventilago bombaiensis* Dalz. (Fig. 1.). It is rare (Ramachandran and Nair 1988; Keshavamurthy and Yoganarasimhan 1990; Vajravelu 1990) and endemic (Ahmedullah and Nayar 1986; Sasidharan and Sivarajan 1996; Nayar 1996) and has so far been recorded in the Western Ghats of Karnataka, Kerala and Maharashtra states. The occurrence of this species in Tirunelveli hills, Tamil Nadu with the evidence from FLORA OF TAMIL NADU, VOL. 1 (Nair and Henry 1983) and the present communication, therefore, forms a new distributional record for Tamil Nadu. A short description of this species is given with an

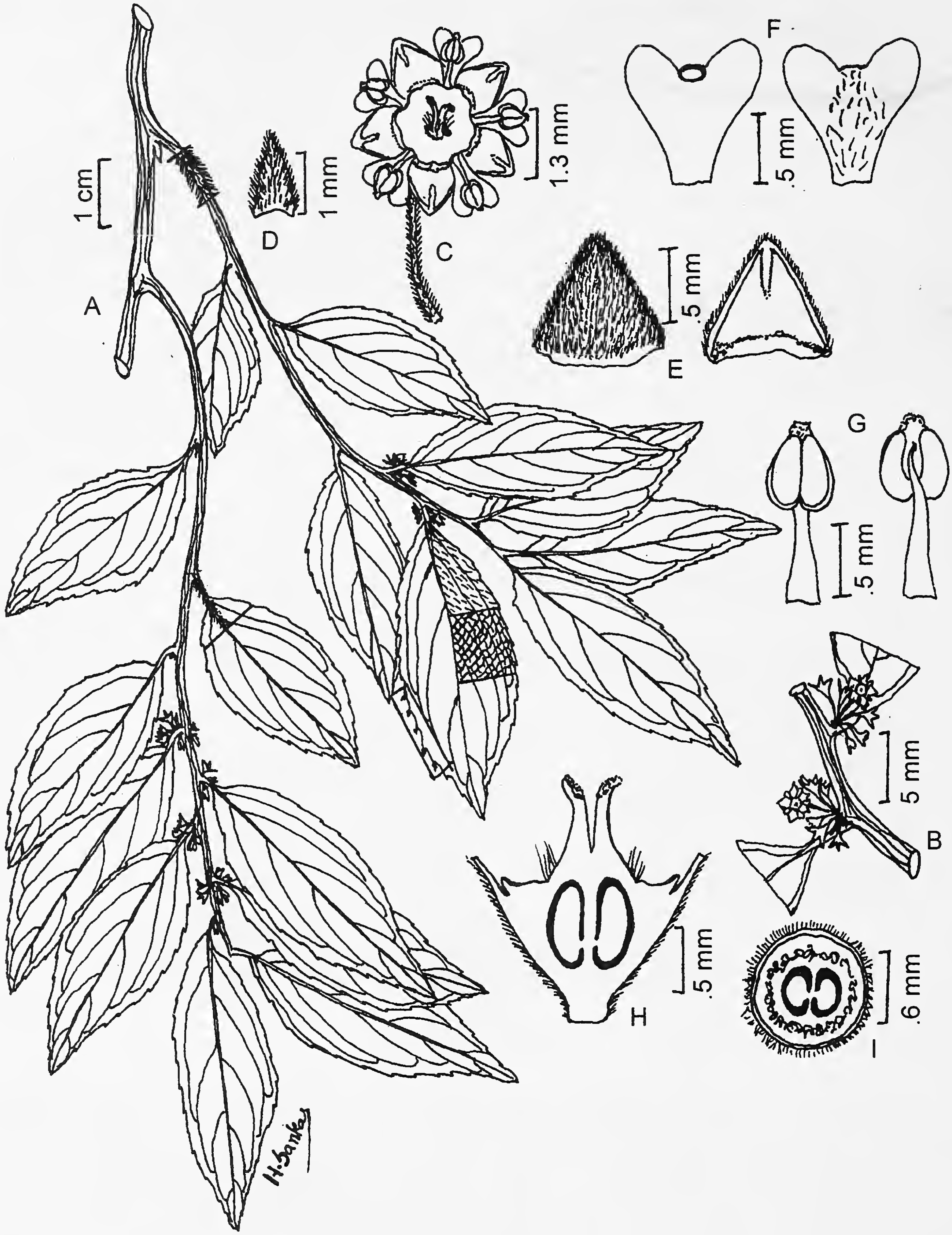

Fig. 1: *Ventilago bombaiensis* Dalz.,
A. Twig, B. Inflorescence, C. Flower, D. Bract, E. Sepal (outer & inner),
F. Petal (inner & outer), G. Stamen, H. L.S. of Pistil, I. T.S. of ovary

illustration, to facilitate field identity. The voucher specimens have been deposited in the St. Xavier's College Herbarium (XCH).

Ventilago bombaiensis Dalz. in Hook, Kew Journ. Bot. Gard. Misc. 3:36. 1851; Cooke, Fl. Pres. Bombay 1:239. 1902 (1:218. 1958 rep. ed); M. Lawson in Hook. f., Fl. Brit. India 1:631. (rep. ed); Gamble, Fl. Pres. Madras 1:218. 1997 (rep. ed); Ramachandran and V.J. Nair, Fl. Cannanore 99. 1988; Ahmedullah & Nayar, Endem. Pl. Indian Region 1:181. 1986; *Smythea bombaiensis* (Dalz.) Baner. & Muker. Indian For. 96:206. 1970; *Ziziphus bombaiensis* (Dalz.) Bedd., Ic. t. 114, 1871.

Flowering: April - July.

Specimens examined: India, Tamil Nadu, Tirunelveli district, Kudamadi, 27.iv.1998, Manickam, 15592 (XCH); Kallimalai, 2.vii.1999, Manickam, 19945 (XCH).

Field Notes: It occurs rarely along exposed, moist deciduous forest at 700 m (Kudamadi) and 850 m (Kallimalai) altitudes. Easily recognized in the field by the crenate-dentate margin of the leaves, and flowers in axillary fascicles.

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34. ON THE OCCURRENCE OF *POGOSTEMON TRAVANCORICUS*, FAMILY LABIATAE AND *ARGYREIA CHOISYANA*, FAMILY CONVOLVULACEAE IN TAMIL NADU

During a botanical exploration in the Tirunelveli hills, Tamil Nadu, we came across two plant species that had not been collected by earlier workers. They are not included in the FLORA OF TAMIL NADU, India. Ser. I: Analysis.

Pogostemon travancoricus Bedd. Hooker, Fl. Brit. India 3: 637. 1885, Gamble, Fl. Pres. Madras 1135. 1921. (Labiatae).

Fl. & Fr.: April-June.

Alt.: 1,400 m.

Specimen examined: Agastyamalai, Tirunelveli district, Tamil Nadu. Manickam, 19075 (XCH).

Note: This species may be endemic to the southern Western Ghats. Though it is reported from Western Ghats, Henry *et al.* (1987) do not include it in the FLORA OF TAMIL NADU, India. Ser. I: Analysis. Therefore, it is an addition to the flora of Tamil Nadu.

Argyreia choisyana Wt. Hooker, Fl. Brit. India 4: 190. 1885; Gamble, Fl. Pres, Madras 908. 1921 (Convolvulaceae).

Fl. & Fr.: December-February.

Alt.: 400-600 m.

Specimen examined: Kalakad-Sengaltheri, Tirunelveli district, Tamil Nadu, Manickam 11732 (XCH).

Note: Gamble reported its occurrence

based on Wight's collection from Kondaparthi and Beddome's collection from Cuddapah. The present collection is the first report from the State.

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HENRY, A.N., G.R. KUMARI & V. CHITHRA (1987): Flora of Tamil Nadu, India. I: Analysis. Vol. 2. BSI, Coimbatore.

35. OCCURRENCE OF *HABENARIA LONGICORNICULATA* GRAH. FAMILY ORCHIDACEAE IN MOUNT ABU WILDLIFE SANCTUARY, RAJASTHAN

On September 15, 1999, I was leading a group of trainees of nature guide service in the Mount Abu Wildlife Sanctuary, Rajasthan. While moving on the Kodra Trail, I observed a single plant of *Habenaria longicorniculata* under bushes of *Lantana camara*. The plant was growing in a crevice of a small rock. It was nearly 80 cm long, having 6 subradical alternate, elliptic leaves. Its long scape bore three developing fruits at the apex. Dried petals were still present on the tips of the developing fruit. Each fruit had a long spur (*c.* 10-12 cm) still intact. The proximal part of the spur was narrow and semi-dried, while the distal part was club-shaped and green.

According to Mehta (1979), two species of genus *Habenaria,* namely *H. digitata* and *H. marginata* are found in the Mount Abu area. *H. longicorniculata* has not been reported earlier from any part of Rajasthan (Shetty and Singh 1987, 1991, 1993). This is the first report of its occurrence in Mount Abu as well as from Rajasthan State, hence it is worth recording.

I thank R.G. Soni, Adl. PCCF and CWLW, U.M. Sahai, CF, M. K. Vijaivergia, Dy. CWLW, Fateh Singh Rathor, Range Forest Officer (WL) for facilities to conduct the biodiversity studies in Mount Abu Wildlife Sanctuary.

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36. DOUM PALM AT BHANGARH, RAJASTHAN?

After reading the short note titled "Doum Palms at Bhamgarh in interior Rajasthan" (*JBNHS*, 1994, 91(3): 476) (author has given the name of place Bhamgarh, actually its pronunciation is Bhangarh in the area), I contacted the Field Director, Tiger Project, Sariska and Range Forest Officer, Tehala to confirm the presence of doum palms (*Hyphaene dichotoma*) at Bhangarh, a locality in their jurisdiction. With the assistance provided by the local authorities, I scrutinized the whole Bhangarh stream thoroughly and reached the conclusion that *Pandanus fascicularis* (Family Pandanaceae) was misidentified as doum palm. *Pandanus fascicularis* is locally called '*Kevda*'. Indeed, it is an old sacred grove of *Kevda*, having plants of different heights and ages. A large number of old plants have taken the shape of small trees and have dichotomous branching also. However, branching is not truly dichotomous in many plants. A good number of plants are more like shrubs. Plants attain erect tree posture and also develop profuse aerial stilt roots *P. fascicularis,* though a garden plant, often runs wild along streams in moist and marshy habitats in many places in Rajasthan like Bhangarh (Alwar), Kevda-Ki-Nal, Bari Talab, Thur (Udaipur), etc.

The author is grateful to Mr. Tejveer Singh, Field Director, Project Tiger, Sariska; Mr. Suresh Sharma and Mr. Satish Sharma of Tehala Range for assistance.

November 2, 1999 SATISH KUMAR SHARMA
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37. *TYPHONIUM FLAGELLIFORME* (ROXB. EX LUDD.) BLUME, FAMILY ARACEAE: AN ADDITION TO THE FLORA OF ORISSA

The genus *Typhonium* Schott., Family Araceae, has 30 species occurring in Southeast Asia, Indo-Malaysia and Northeastern Australia (Mabberley 1997). In India, the genus is represented by 16 species (Santapau and Henry 1973), which are mostly distributed in the states of West Bengal, Orissa, Bihar, Tamil Nadu, Kerala, Maharashtra, Himachal Pradesh and the western Peninsula. During field collection of *Typhonium trilobatum,* to study its medicinal properties, we came across another species of *Typhonium*, which closely resembles *trilobatum*, but differs from it in a number of morphological characters. On critical examination, its identity was ascertained as *Typhonium flagelliforme*. Interestingly, this species has not been reported so far from Orissa (Saxena and Brahmam 1995) and this is a new distributional record for the state.

Typhonium trilobatum and *T. flagelliforme* can be distinguished from each other by the following consistent morphological characters:

1. Limb of spathe narrowly lanceolate, acuminate, not expanded. Neuters above the females short and stout. Appendage longer than limb of spathe .... *T. flagelliforme*

— Limb of spathe open, broadly ovate. Neuters above the females long, filiform, curved. Appendage not longer than limb of spathe .... *T. trilobatum*

Correct nomenclature, botanical description, notes on habitat, phenology, and distribution of the newly recorded species are given below.

Typhonium flagelliforme (Roxb. ex Lodd.) Blume, Rumphia 1: 134. 1835; Gamble, Fl. Presid. Madras 3: 1100. 1935. *Arum flagelliforme* Roxb. [Hort. Beng. 65. 1814, nom. Nud.] ex Lodd. Bot. Cab. 396. 1819. *Typhonium cuspidatum* (Blume) Decne Herb. Timor in Ann.

Hist. Nat. 3: 39. 1834; Hook. f., Fl. Brit. India 6: 511. 1893; Prain, Bengal Pl. 2: 1107. 1903. (Araceae).

Tuberous, erect, stemless herbs; tuber up to 2 cm diameter, sub-globose. Leaves radical, up to 8.0-15.0 x 2.0-6.0 cm, of variable width, ovate-oblong or lanceolate, acute or acuminate, cordate at base, hastately 3-lobed or tripartite, rarely entire, long petioled, reticulately veined, green above, glaucous beneath. Petiole 10.0-15.0 cm long, base sheathing. Spathe up to 20 cm long (including the tail), lurid red, papillose within; limb of spathe with short lanceolate base produced into a very long, slender tail. Peduncle slender, up to 15 cm long. Spadix shortly stipitate, appendage produced into a long filiform tail, a little longer than spathe. Male inflorescence up to 6 mm long, cylindric; yellow. Female inflorescence sub-globose. Neuters above female inflorescence few, clavate or obovoid with purple tip, those above the male subulate, white. Anthers minute, yellow. Ovary clavate green. Berries ovoid, 1-2 seeded; seeds globose, albuminous.

Not common; in shady moist localities and grassy waste places.

Fl. & Fr.: July-September.

Distribution: India, Bangladesh, Myanmar, Thailand, Cambodia, Vietnam, Malaysia and Indonesia.

Specimens examined: Jashapada, Cuttack district, Orissa, 17.vii.1999, P.C. Panda 6675; Bhubaneswar, Khurda district, Orissa, 17.vii.1999, S.C. Jena, 6671.

Illustration: Wight, Icon. t. 791. 1844.

Typhonium flagelliforme can be distinguished from its closely allied species *Typhonium trilobatum* in the field by its short height, smaller and shallowly lobed leaves, small and smooth tubers with a brownish-black skin and nature of the inflorescence. Both occur in similar habitat, but the former prefers relatively open places and soil having less organic materials.

June 5, 2000

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38. OBSERVATIONS ON THE GENUS *RADIOCOCCUS*, FAMILY CHLOROPHYCEAE, A NEW RECORD FOR INDIA

(*With one text-figure*)

Schmidle (1902) established the genus *Radiococcus*, a chlorococcalean. This genus is widely reported from Belgium, Germany, England (Schmidle 1902) and U.S.A. (Smith 1950). According to Philipose (1967), three species of *Radiococcus* are known to occur, which are not yet reported from India. Although Singh *et al.* (1953) have reported an alga from Allahabad, which they have identified as *Radiococcus nimbatus*, the description does not tally with that of Schmidle for this alga. The present paper describes *Radiococcus nimbatus*, which could be the first authentic report from India.

The alga was collected from Ramgarh Lake, Jaipur while surveying the freshwater algae of Rajasthan in September. It was found growing in slow running water in a shallow ditch with other chlorococcalean and blue-green algae. The

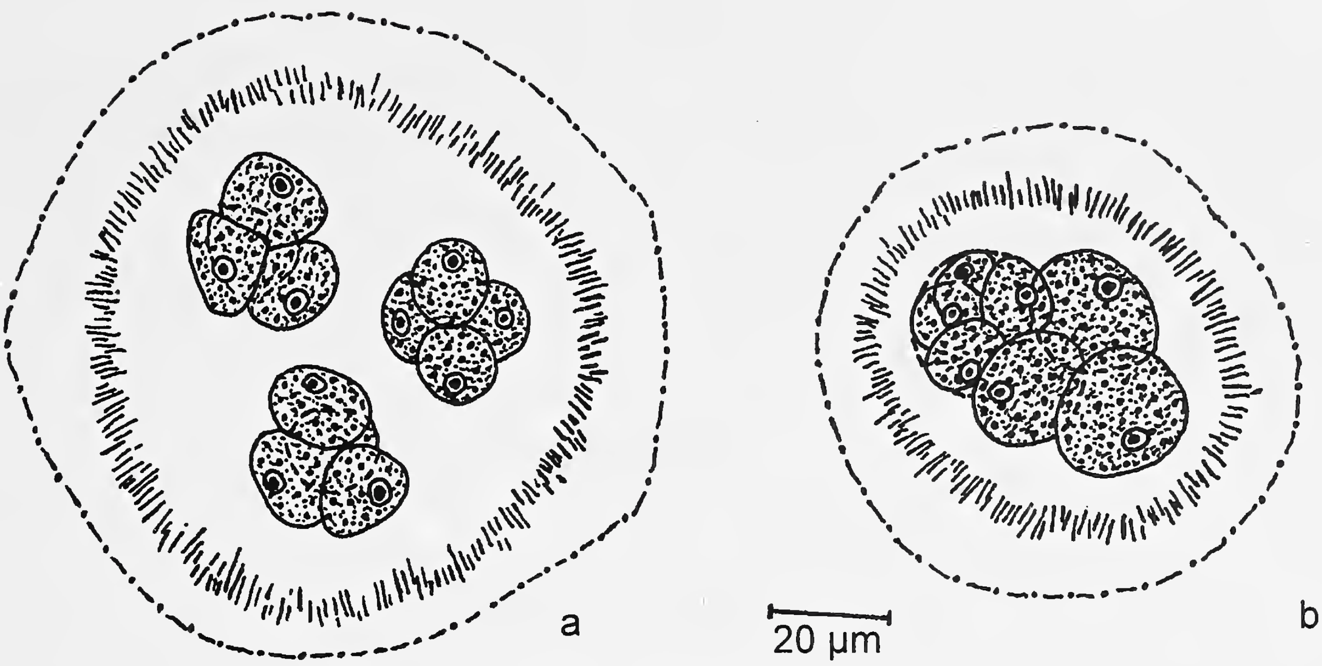

Fig. 1: *Radiococcus nimbatus*, a. Coenobia surrounded by mucilaginous sheath with fibrillar structures, b. Formation of autospores in a coenobium.

temperature of the water was 27 °C and pH 8.0. It was reared into a unialgal culture using standard microbiological technique and maintained in Bold's Basal Medium (Bischoff and Bold 1960) and Biphasic Medium (Pringsheim 1946).

The alga was a coenobium of four cells and was surrounded by a wide envelope of mucilage with radiate fibrillar structures (Fig. 1a). Cells in the coenobium were usually arranged in a tetrahedral or opposite, decussate manner and grouped in fours (Fig. 1a), but occasionally one-celled, two-celled and eight-celled stages were also observed. The four-celled coenobia measured 14-23.5 µm; the individual cells measured 7.8-14.0 µm. The cells were spherical, but sometimes turned oval due to mutual pressure. Each cell possessed a single parietal chloroplast with a pyrenoid, which was normally positioned towards the periphery.

Reproduction was performed by autospore formation (Fig. 1b) and each cell of the colony was capable of forming daughter coenobia. The autocolonies were liberated by tearing through the parent cell wall.

Schmidle (1902) and Smith segregated *Radiococcus* from *Westella* based upon the characters pertaining to the gelatinous matrix and arrangement of cells in a coenobium. Different species of the genus have been characterized by their cell and colony size and contents. Singh *et al.* (1983) reported *Radiococcus nimbatus* from Allahabad, India. According to them, the cells were 3-8 µm in diameter. The Camera Lucida drawing showed a smooth mucilaginous envelope without fibrillate radiation. Schmidle (1902) compared the measurements and cell structure of *Radiococcus nimbatus* and *R. wildemanni.* He mentioned that cells of *R. wildemanni* measured 3-5 µm, while that of *R. nimbatus* measured 8-15 µm. The present alga, in all its features, resembles the type species described by Schmidle (1902). Therefore, it is the first record of the genus *Radiococcus* from India.

June 5, 2000

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■ ■ ■

CORRIGENDUM

JBNHS, Vol.98(3), p. 440, column 2, line 13

for: While sliding down a slope, its head got sandwiched between two or more tree trunks from which it could not recover itself (Jain and Saandeep 2001).

Read: While sliding down a slope, its head got sandwiched between two or more tree trunks from which it could not recover itself. There were similar cases of strangulation records from Karnataka (Jain and Saandeep 2001).

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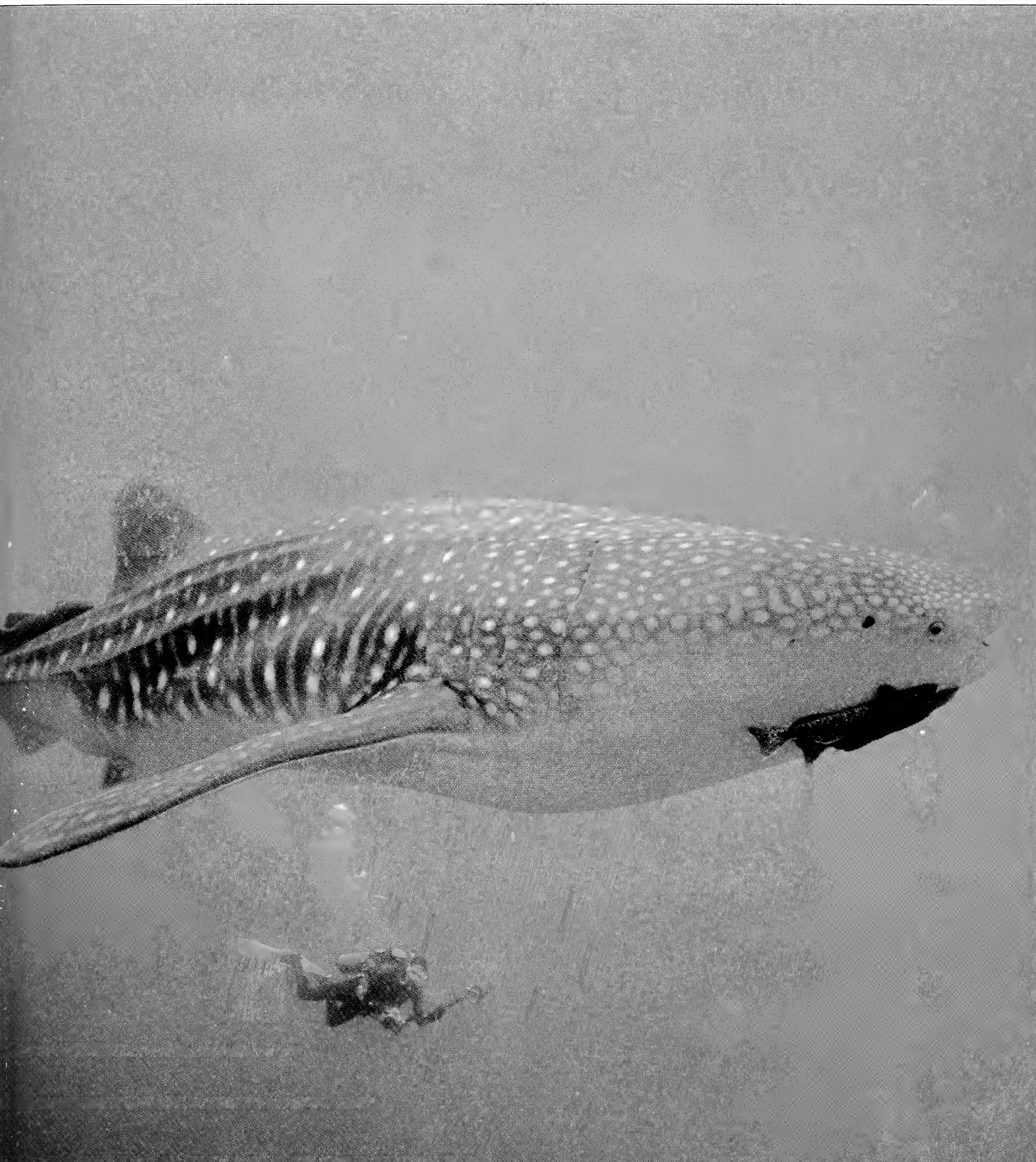

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1. Papers which have been published or have been offered for publication elsewhere should not be submitted.

2. Papers should be submitted in duplicate, typed double space. Preferably an additional copy should be submitted on a floppy diskette (3.5") using MS Word.

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4. Photographs for reproduction must be clear, with good contrast. Prints should be at least 9 x 12 cm and on glossy glazed paper. Text-figures, line drawings and maps should be in Indian ink, preferably on tracing paper.

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9. For the standardised common and scientific names of the birds of the Indian subcontinent refer to *Buceros* Vol. 6, No. 1 (2001).

Hornbill House,
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Editors,
Journal of the Bombay Natural History Society

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NEW DESCRIPTIONS

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Cover Photograph: Whale shark *Rhincodon typus* by Phillip Colla

Editorial

SCIENCE AND SENTIMENT

A little learning is a dang'rous thing;
Drink deep, or taste not the Pierian spring:
There shallow draughts intoxicate the brain,
And drinking largely sobers us again.
— Alexander Pope

Dr. Sálim Ali was a pragmatic wildlife conservationist; he thought first with his head and then used his heart, and he was respected for it. Today, unfortunately, there is a trend for proactive "conservationists" — many of whom are not even trained academically in wildlife studies, to hog the media limelight with fancy programmes and solutions.

Last year, the Government of India issued a notification banning capture of ALL species of Elasmobranchs by placing them in Schedule I of the Wildlife (Protection) Act, 1972 (Notification in the Gazette of India, Part II, Section 3(ii), dated July 11, 2001). I would like to comment on this.

I fully endorse listing whale sharks and manta rays (also called devil rays — *Mobula diacantha*) in Schedule I. The reason given for placing elasmobranchs in Schedule I was that foreign fishing boats come to the Andaman Sea, poach sharks, cut off their fins and throw the sharks back into the sea. The procedure is despicable and deserves to be severely condemned. But the remedy is to beef up naval and coast guard patrolling, confiscate the boats and fishing gear, and have stiff jail sentences and hefty fines to deter the perpetrators. Instead, in a knee-jerk reaction, all elasmobranchs were brought into Schedule I.

There is no target fishery for elasmobranchs, i.e., fishermen do not have gear intended to catch only these fishes. These fish form a by-catch, i.e., they come in gear designed to catch other fishes and are thus caught along with them.

Some fifty years back, long-line fishing was in vogue. This gear was not primarily meant for catching sharks, but sharks were caught in fair numbers, being attracted by the bait and getting hooked. As this gear is labour intensive, it is no longer in use. Nowadays, apart from stray elasmobranch catches in trawl nets, sharks are mainly caught in gill-nets — here, too, as a by-catch, because gill-nets are used mainly to catch large, commercially important fish such as giant thread-fin (*Polynemus indicus*), Indian salmon (*Eleutheronema tetradactylum*) and jewfish (*Pseudosciaena sina*, *Otolithus brunneus*).

Pelagic sharks have to swim all the time, even during sleep, in order to respire. If they stop moving forward, their respiration ceases and they die. Hence, once sharks are caught in a gill-net, their respiration stops and they suffocate to death in a few minutes.

Gill-nets are lifted on to the fishing boat every few hours, so, by the time these are hauled up the sharks are already dead. Unlike in western (developed) countries, where only shark fins are used for soup, in India shark flesh is also consumed, so that no part of a shark is wasted. Shark liver oil is much richer in Vitamin A content compared to cod liver oil; in fact, in order to conform to the international standard of 20,000 International Units of Vitamin A per millilitre of oil, shark liver oil has to be diluted with groundnut oil.

Sharks are thus a valuable source of income to fishermen. Traditionally, fishermen bring them (along with rays and skates, which are also elasmobranchs) to the market.

Once these are banned, the fishermen would be forced to throw them back into the sea. And, as explained above, since they are already dead by this time, the basic purpose of conserving them would not be served. On the contrary, their putrefying flesh will only serve to increase sea water pollution.

One reason for placing sharks in Schedule I is that sharks are not prolific breeders, but this is only a result of efficient evolution over tens of thousands of years. Sharks are at the apex of the food pyramid, so that they have to be fewer in number, so as to be in harmonious balance with their prey population; otherwise they would soon exhaust their food supply, and then die of starvation.

Again, being predators at the top of the food pyramid, they have no natural enemies (except man). So, when the graph of natural mortality versus fishing mortality is drawn, the ratio appears to be skewed, and can be misinterpreted by novice conservationists to show high fishing mortality.

Because of considerable resentment necessitating reconsideration, common sense finally prevailed, and the Government have notified again (Notification in Part II, Section 3, Subsection (ii), Extraordinary of the Gazette of India dated December 15, 2001), relaxing the blanket ban and imposing restrictions only on certain species by placing them in Schedule I of the Wildlife (Protection) Act.

Along with elasmobranchs, sea horses, corals, many sea shells and ALL sea cucumbers were also placed in Schedule I of the Wildlife (Protection) Act. I fully agree that sea horses and corals, and also a few sea shells are threatened due to over-collection and deserve protection. A few (three or four) species of the larger sea cucumbers are collected for export, as they form the basic ingredient of "trepang" or "beche-de-mer" — a culinary delicacy in southeast Asia.

In the 1960s, Mr. S.R. Sane and I were studying the seashore life of Mumbai, and this resulted in a number of scientific papers. One of these dealt with the Echinodermata of Mumbai (comprising starfish, sea urchins, sea cucumbers and feather stars). Unlike many fish and invertebrates, these forms cannot be identified just by looking at the live animals. Their identity (like that of sponges) is based on their hard spicules, which have to be seen under a microscope only after macerating the skin in hot acids.

In our studies, too, this method was used. We collected, at the most, half a dozen specimens of each species. Almost all of these were recorded for the first time from Mumbai. Another notable find was that some species are not permanent residents of Mumbai's sea shores, but come sporadically, as if by magic, from somewhere else and, in that year, are found in their hundreds. Our finding has contributed, albeit in a small way, to the study of this little known group. But today, unfortunately, we cannot collect even a single specimen without infringing the law. Can science progress in this manner?

B.F. CHHAPGAR

ACKNOWLEDGEMENT

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CITATION OF IC/EC NUMBERS FOR GENETIC MATERIALS

It is brought to our notice by the National Bureau of Plant Genetic Resources (NBPGR), Pusa Campus, New Delhi 110 012, India, that authors writing papers on particular plant materials (genetic materials) should indicate IC numbers for Indigenous Collections and EC numbers for Exotic Collections. Authors can directly procure these single accession numbers for each genetic material from NBPGR. In the present Intellectual Property Rights regime, it is in our national interest that all the germplasm material possess a single national accession number.

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Editors

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MONITORING THE INCUBATION BEHAVIOUR OF THE HOUBARA *CHLAMYDOTIS UNDULATA* WITH A TEMPERATURE LOGGER DUMMY EGG[1]

QIAO JIANFANG, YAO JUN[2] AND COMBREAU OLIVIER[3]

(*With two text-figures and one plate*)

Key words: China, Xinjiang, egg temperature, *Chlamydotis undulata,* houbara

The incubating behaviour of two female houbara was successfully monitored with the help of a temperature logger egg from May 22 to June 11, 1999 in the Xinjiang province of the People's Republic of China. As a rule, the female showed a bimodal daily activity pattern (morning and evening) during the incubation stage. On an average, a female will leave her nest 3 to 9 times daily for periods ranging from 8 to 26 minutes, but will spend an overall 94±2% of her daily time on the nest. The average daily temperature of the egg, when the female attended the nest, varied from 31.9 °C to 36.5 °C. When the female left the nest unattended, the temperature of the egg generally dropped to an average minimum of 24.9 °C, but could also rise to 40.6 °C (absolute maximum) in hot conditions. Following the seasonal increase in daily air temperature as summer progressed, the average daily egg temperature increased from 31.9 °C to 36.2 °C as the incubation advanced.

INTRODUCTION

For several years, the National Avian Research Centre (NARC) in Abu Dhabi has been developing an ambitious project aimed at defining a conservation and management strategy for the Asiatic subspecies of the houbara, *Chlamydotis undulata*, based on sound scientific knowledge of its population dynamics (Launay 1998). A houbara caught in Abu Dhabi, and followed by satellite tracking, migrated to the centre of China in spring and summer 1997. With these in mind, a three-year agreement between NARC and the Xinjiang Institute of Ecology and Geography, People's Republic of China, was started in 1997. The agreement focuses on the study of the breeding biology, migration and the implementation of pluri-annual surveys to monitor the general trends in the population.

Despite the high conservation profile of the houbara, there are few ecological studies conducted in the wild. In particular, information on the egg temperature and activity rhythm of the houbara in the wild is very limited in the literature, and many aspects remain unknown. Some information on the feeding activity of the incubating female was collected by Gaucher (unpubl. data) in Algeria, and a preliminary observation of the incubation behaviour was conducted by Launay *et al.* (1997) in Uzbekistan.

This study was conducted with a temperature logger inserted in an egg and added to a nest clutch in the wild. The logger presented

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information on the changes in the egg temperature and on the activity rhythm of the incubating female.

Study Area and Method

The study was conducted from April 27 to July 15, 1999 by a team from the National Avian Research Centre (UAE) and the Xinjiang Institute of Ecology and Geography (China).

The study area is located in the semi-desert steppes of the eastern fringe of the Jungar Basin, Xinjiang Province of the People's Republic of China. The area was chosen on the basis of previous observations of houbara breeding (Gao *et al.* 1997). It is a high plateau bordered by the Tian Shan Mountains to the south and complex sand dunes to the north. The substrate is predominantly clay and gravel to the south, changing to sand towards the north. The topography of the area varies from flat to slightly undulating. Various associations of *Artemisia* sp., *Anabasis* sp., and *Ceratoides* sp. dominate the vegetation in the area. This vegetation is typically short (5-10 cm). Irregular bushy formations of *Salsola* sp. and *Haloxylon* sp. occur sparingly. More than twenty ephemeral plant species, including *Plantago* sp., *Lepidium* sp., *Ceratocarpus* sp., *Tulipa* sp., *Scorzonera* sp., and *Corydalis* sp. commonly occur in early spring following precipitation. The overall plant cover lies typically within 10 to 20%.

Information on incubation behaviour was obtained by means of a dummy egg containing a temperature logger. One infertile egg from a natural nest was cut open and drained, and the temperature logger was fitted inside with cotton wool. The two halves were then glued together. The data logger was a Stow Away TidbiT Temp logger (TBI32) made by ANSET (USA) with a ±0.4 °C accuracy. The logger can operate from -30 °C to 70 °C. It was set to take one reading every two minutes, which allowed for 24 days of monitoring. The logger was downloaded to a computer once at the end of the study.

The air temperature was recorded twice a day, at 0700 hrs and 1400 hrs, and was compared with the temperature of the logger egg when the female left the nest.

We studied the effect of disturbance by cars on the behaviour of the incubating female. All the cars were equipped with a GPS set to record the track routes, which were downloaded to a computer every alternate day. The track routes were then compared to the nest locations and the effect on the females' behaviour was assessed through the changes in egg temperature following our visits to the nests. The temperature was assessed when the car approached the nest, giving another 15 minutes to allow the egg to cool after the female left the nest.

Results and Discussion

The temperature logger egg was placed successively inside two nests, which had already been in incubation. It was left in the nest until the hatching of the natural eggs. From May 22 to 28 (5 complete days), the egg was placed in a nest of 4 eggs and then moved to a nest of 5 eggs from May 28 to June 11 (12 complete days).

Incubation behaviour: We observed a decrease or series of decreases in the temperature of the egg in the early mornings and evenings (Fig.1A-E). This was interpreted as the time when the female left the nest for other activities, such as feeding. Serial drop in temperatures could be due to predators, cars or displaying males disturbing the female. In Uzbekistan, Launay *et al.* (1997) found that the presence of displaying males in the vicinity of the nest was obviously disturbing for the nesting female.

On an average, a female will leave her nest 5.2 ±1.7 times (3 to 9 times) a day for periods from 8 to 26 minutes (average: 17.4 ±5.3 min). The total daily duration of these activity periods varied from 50 to 134 minutes (average 86

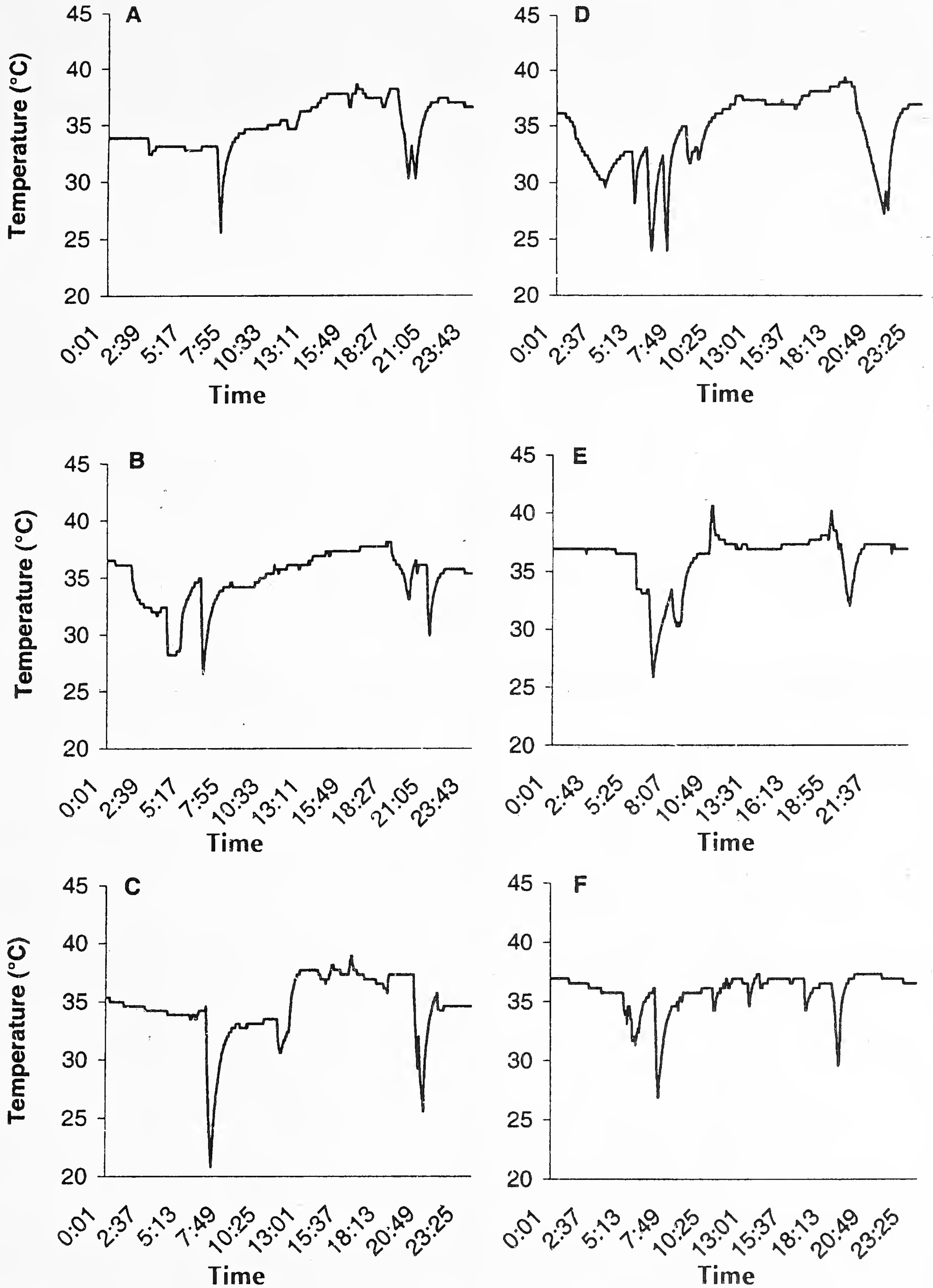


Fig. 1: Daily egg temperature at one houbara nest as relayed by the logger egg (A: hatching day – 11, B: hatching day – 10, C: hatching day – 9, D: hatching day – 3, E: hatching day – 2, F: hatching day).

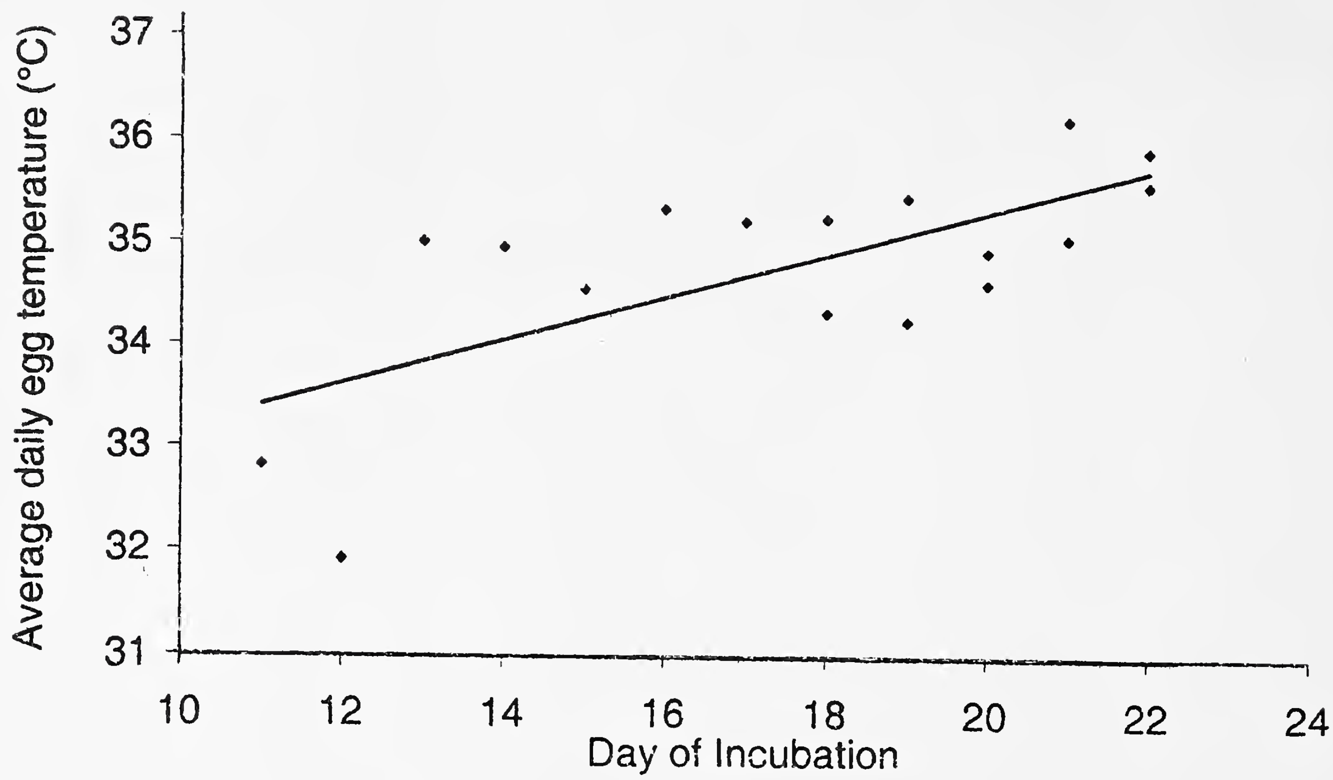


Fig 2: Linear regression of the average daily egg temperature during the incubation stage on the days of incubations (two nests).

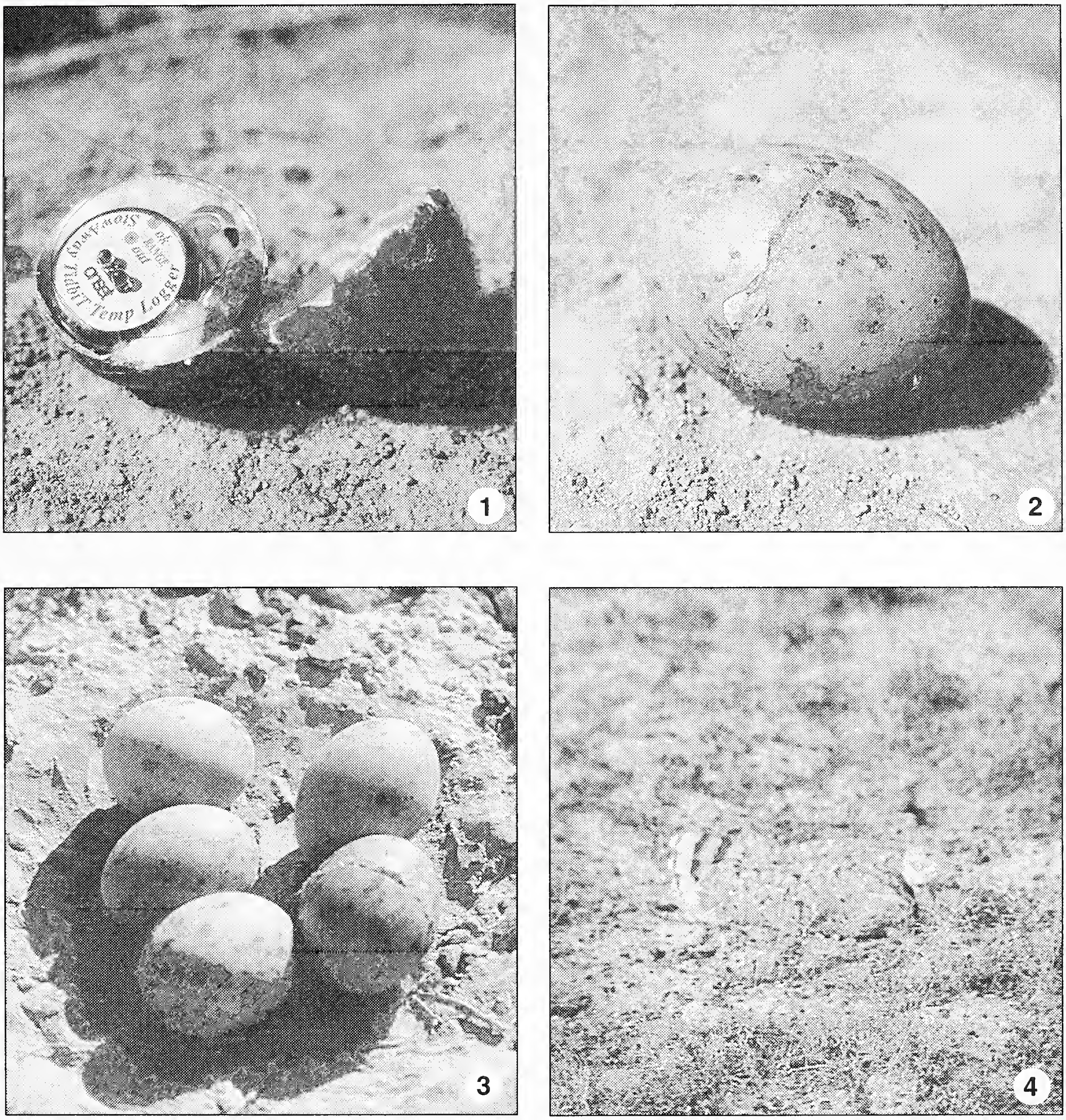
±23 min), independently of the air temperature (r^2=0.100, df=16, F=1.6, NS).

Activity periods normally occurred between 0613 and 1005 hrs in the mornings, and between 1845 and 2213 hrs in the evenings (Anova: F = 7.76, d.f. = 67, $p < 0.001$) making a bimodal daily activity pattern (12 days out of 17). In this respect, the activities of an incubating female were not different from those of non-breeding birds (Combreau and Launay 1996).

During incubation, the female spent 94 ±2% of her daily time on the nest. This observation matches that of Verbeek (1972), who recorded the activity of yellow-billed magpies (*Urocissa flavirostris*) in the field and found that females spent an average of 92.3 % of daily time on the nest. The temperature relayed by the logger showed successive variations of very small amplitude (0.4 °C) when the female sat on the nest. However, on the day of hatching, the data logger relayed many variations of amplitude in the range of 1 to 2 °C, suggesting a change in behaviour (Fig. 1F). Such variations of temperature were observed 8 times for one nest and 9 times for the other. These changes in the egg temperature were not interpreted as activity periods. We believe that the bird stayed on the nest all the time, but kept turning the eggs to facilitate the hatching.

The egg temperature measured 15 minutes after a possible disturbance by a car was found to be positively correlated to the distance from the car to the nest (r^2 = 0.158, F = 10.5, d.f. = 57, p = 0.002). The effect was restricted to a radius of 500 m around the nest. A linear regression analysis for distances ranging from 500 m to 2 km showed no effect at all (r^2 = 0.0026, F = 0.41, d.f. = 155, NS). This suggests that the female houbara incubating a nest is sensitive to human presence in a radius of 500 m. This effect, however, is small, (r^2 = 0.158) and the female returns quickly to the nest when the disturbing factor has gone. This behaviour of leaving the nest in case of danger seems to be the rule, but there are numerous exceptions. A

Jianfang, Qiao *et al.*: Houbara *Chlamydotis undulata* PLATE 1



PICS: O. COMBREAU

Figs 1-4: 1. Details of the temperature logger egg; 2. The temperature logger egg ready to place in a nest; 3. The temperature logger egg placed in a nest with 4 eggs; 4. A female houbara incubating her nest containing the temperature logger egg

number of times, we have observed females which would stay on the nest with the car or even human beings in close proximity (10-20 m).

Egg temperature: The average egg temperature, when the female was on the nest, varied from 31.9 to 36.5 °C (average, 34.9 ±1.1 °C). When the female left the nest for her daily activity, the temperature of the egg dropped to an average minimum of 24.9 ±3.2 °C (19.9 to 28.8 °C) in the morning and 29.8 ±2.8 °C (25.6 to 33.5 °C) in the evening (t-test, t=2.2, d.f. = 12, $P < 0.001$). This difference in the egg temperature was most easily explained by the difference in the average air temperature that ranged from 14.5 ±3.2 °C in the morning to 23.6 ±3.9 °C in the afternoon.

As the incubation advanced, we observed a general increase in the daily average temperature of the egg from 31.91 to 36.18 °C (average 34.8 ±1.0 °C) ($r^2 = 0.48$, F = 13.8, d.f. = 16, P = 0.002). For both nests, daily average egg temperature was highest on or around the hatching day (Fig. 2). The most likely explanation is an increase in the average air temperature as the incubation advances ($r^2 = 0.47$, F= 13.1, d.f. =16, P = 0.002). This is confirmed by the strong relation observed between the daily maximum air temperature and the daily maximum egg temperature ($r^2 = 0.52$, F = 16, d.f. = 16, P = 0.001). An increase in egg temperature as the incubation stage advances has also been observed in other bird species (Steven *et al.* 1997). In 1982, Ralph explained this as resulting from the heat production of the embryo, the changes in substrate thermal conductivity and the changes in nest air temperature.

Quite surprisingly, in twelve out of seventeen cases, when the female was incubating the nest, the temperature of the egg increased gradually from morning to afternoon. On an average, the temperature of the egg rose to a maximum of 36.4 ±1.9 °C in the morning and 38.1 ±1.4 °C in the evening (t-test: t = 2.1, d.f. = 16, p = 0.0011). No obvious biological reasons could explain these differences, and the most likely explanation would be the difference in air temperatures between morning and afternoon. For both nests, we observed occasionally an absolute maximum temperature in the range of 40.2-40.6 °C, attained gradually in 15 or 20 minutes. The temperature stayed high for about 30 minutes, then decreased gradually to a more normal temperature around 37 °C. Such high temperatures in an incubating egg raise concern about the survival of the embryos, which would surely be killed under artificial incubation at these temperatures. In our study, the thermodynamics of the logger egg was obviously different from that of natural eggs. Being empty of fluids, it probably gained and lost heat much faster than natural eggs, and responded more quickly to changes in ambient temperature or orientation of solar radiation. When the logger egg reached temperatures above 40 °C, the temperature of the natural eggs may have been within the normal range. This is confirmed by the production in 2 nests of 3 and 4 vigorous chicks from 4 and 5 eggs, respectively.

Conclusions

Placement of a data logger in an egg was a useful method for obtaining egg temperatures and behavioural information on the incubating houbara female. Moreover, the introduction of a transformed egg in a nest found in the wild did not affect hatching, suggesting that the effect on the incubation behaviour of the female was negligible. The logger constantly monitored the egg temperature, from which deductions on the female's behaviour could be made without long periods of observation in the field. However, sometimes it was difficult to interpret accurately the changes in the egg temperature in terms of the female's behaviour, especially when successive changes of small amplitude were

observed. Further observations would be necessary to fully understand the female's activity on the nest.

Though interesting behavioural results were obtained, the inaccuracy (±0.4 °C) as well as the difference in thermodynamic characteristics of the logger egg curtails the interpretation in terms of the temperature of incubation in houbara. It is, therefore, difficult to make proposals for modifying the incubation parameters used in artificial conditions. However, the female does not tend to keep the egg temperature constant as is done in incubators in captive breeding programs. On the contrary, severe variations of temperature were commonly observed, causing no lethal effect on the embryo. It is suggested that such variation in the incubation temperature in captivity might be beneficial to the development and hatching success of the eggs.

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PHENOTYPIC AND BEHAVIOURAL CHARACTERISTICS USED TO IDENTIFY WILD BUFFALO *BUBALUS BUBALIS* FROM FERAL BACKCROSSES IN NEPAL[1]

Joel T. Heinen[2]

(*With two text-figures*)

Key words: *Bubalus arnee*, *Bubalus bubalis*, feral buffalo, Kosi Tappu Wildlife Reserve, Nepal, wild buffalo

All remaining populations of the wild Asiatic buffalo are known to cross breed with domestic and feral forms living in the vicinity of the handful of reserves in which the species is found. Censuses of these animals done in various places in India and Nepal have been criticized because researchers have used various criteria to differentiate wild buffalo versus feral backcrosses, thus rendering population estimates unreliable. Due to the highly endangered status of the wild buffalo, there is an urgent need for a set of criteria that can be applied more broadly to distinguish wild from feral forms. This paper describes the phenotypic and behavioural characteristics used to census wild buffalo and feral backcrosses in Kosi Tappu Wildlife Reserve, Nepal, which contains the last Nepalese population of the species. It is hoped that other researchers in the region may find these field characteristics useful in identifying wild stocks in South and Southeast Asia, where they are still thought to occur. Ideally, in all cases, detailed genetic studies are needed to plan managerial interventions such as translocation projects. Given the expense of such studies, it is suggested that translocations can be planned using consistent field identification criteria, until such time as more detailed genetic work is done.

Introduction

The decline of all species of Asian wild cattle and buffalo resulted in the restructuring of the Asian Wild Cattle Specialist Group (AWCSG) in 1995, by the Species Survival Commission (SSC) of IUCN — The World Conservation Union. A background document (Read *et al.* 1995) and draft action plan (Hedges 1995) were prepared and a meeting at Khao Kheow Open Zoo in Chonburi, Thailand was held in July 1995 to conduct a Conservation Assessment and Management Planning Workshop for four species of cattle and four species of buffalo that occur in various Asian range states (Byers *et al.* 1995). From the formal talks and general discussion, it was apparent that there is little information on the former or current status of the wild buffalo *Bubalus bubalis* [=*B. arnee*] (Groves 1981), and that all populations are endangered to critically endangered for many reasons (Srikosamatara and Suteethom 1994, Heinen and Srikosamatara 1996). Wild buffalo have recently been listed under CITES Appendix II as a result of the known threats to all wild populations (Anon. 1997).

Since the species has been in domestication for at least 4,500 years (Clutton-Brock 1989), even the historical geographic range is in question. It is known that wild buffalo occurred at least from peninsular India to Southeast Asia, but there is evidence of buffalo in the Indus Valley over 5,000 years ago (Nowak 1999) and the wild form may have occurred from Mesopotamia eastwards (Sinclair 1977). The populations in Sri Lanka (Eisenberg and Lockhart 1972), peninsular Southeast Asia, Borneo and Java (Hedges 1995) have come into question, as it is not known whether they are partly or wholly of

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feral origin. Wild Asiatic buffalo have probably been in decline for long periods of time (Daniel and Grubh 1966, Seshadri 1986). Current site locations of putative wild stock are western Thailand, East and Central India, southern Bhutan and southeastern Nepal (Corbet and Hill 1992) in several isolated reserves.

A major concern is that domestic and feral buffalo are completely inter-fertile with wild buffalo; thus the genetics of wild stock are in question and field censuses become difficult when feral and wild forms look similar. This is not an isolated case. Wild sheep and goats of several species (Shackleton 1997), Eurasian wildcats (*Felis sylvestris*; Nowell and Jackson 1996), yak (*Bos mutus*; Schaller 1998), African wild ass (*Equus asinus*; Duncan 1992), and wild pig (*Sus scrofa*; Oliver 1993) are all known to interbreed with domestic and/or feral forms. In all these cases, however, known wild populations exist that are not affected by domestic mixing. Buffalo, Bactrian camels *Camelus ferus* (Schaller 1998) and Ethiopian wolves *Canis simiensis* (Sillero-Zubiri and Macdonald 1997), may be under greater threat, because domestic or feral forms (shepherd dogs *Canis familiaris* in the case of the Ethiopian wolf), have access to breeding with wild stock through most or all of the geographic range.

Besides genetic introgression, threats of disease transmission are high when domestic and wild forms intermingle; this has been raised as a conservation issue for a number of species. Since detailed genetic studies are expensive, there is need for consistent field identification criteria that can be generally applied to census wild stock.

The American Zoo and Aquarium Association recommended field censuses and clarification of the species/subspecies of Asiatic buffalo (Read 1999). Antibody research is also needed to test for common diseases for all populations. Among the putative wild populations, it was thought that the one in Kosi Tappu Wildlife Reserve, Nepal (the only extant Nepalese population) has a good chance of containing some pure wild stock. This is also likely in some populations in Assam and Madhya Pradesh (Divakar 1977, Divakar and Bhushan 1988), although there is debate about the genetic integrity of the stocks (Choudhury 1994). In spite of its importance as the wild progenitor of the domestic buffalo, the species is poorly studied (Cockrill 1967). The introduced feral population in Australia is probably the best known (Tulloch 1970, 1978, 1979). Due to the endangered status and importance of this species worldwide, the Department of National Parks and Wildlife Conservation in Nepal (DNPWC) is considering translocation of buffalo from Kosi Tappu to one or more of Nepal's other lowland parks or reserves to secure the species. *Bubalus bubalis* is known to have occurred in Chitwan National Park until the 1960s (Seidensticker 1975) and probably once ranged throughout the Nepalese lowlands, including areas now protected (Fig. 1). The phenotypic and behavioural characteristics used for the census in Nepal are described herein. It is hoped that these criteria will also be useful to researchers studying the species elsewhere.

Description of the study area and previous research

Kosi Tappu Wildlife Reserve was established in 1976 and is spread over 175 sq. km. It is Nepal's only Ramsar site and contains extensive wetlands that are important stopover and wintering areas for waterfowl (Sah 1997). It is located on the floodplain of the Kosi River in Sunsari, Saptari, and Udayapur districts in southeastern Nepal (75 to 100 m above msl; Fig. 2). The reserve is subject to extreme flooding during monsoon; buffalo and other ungulates frequently leave at that time and seek refuge in croplands. About 80% of the land area is dominated by tall grasses such as species of *Saccharum*, *Phragmites* and *Typha*, and open river banks. Mixed forests of *Bombax*, *Dalbergia*

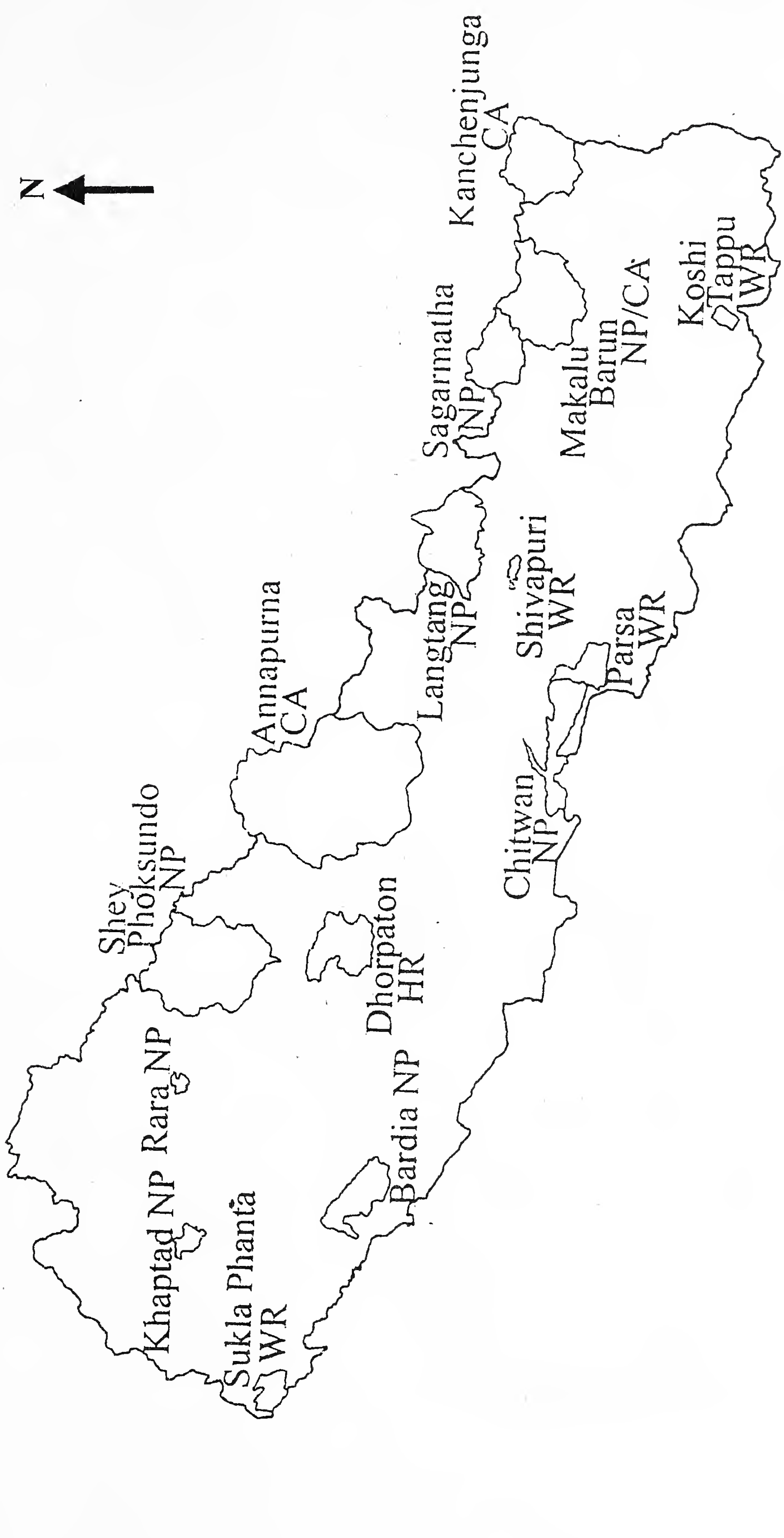

Fig. 1: Locations of the protected areas of Nepal
(NP, National Park; WR, Wildlife Reserve; CA, Conservation Area; HR, Hunting Reserve.
The five protected areas located along the southern border are all considered within the historical geographical range of wild buffalo.)

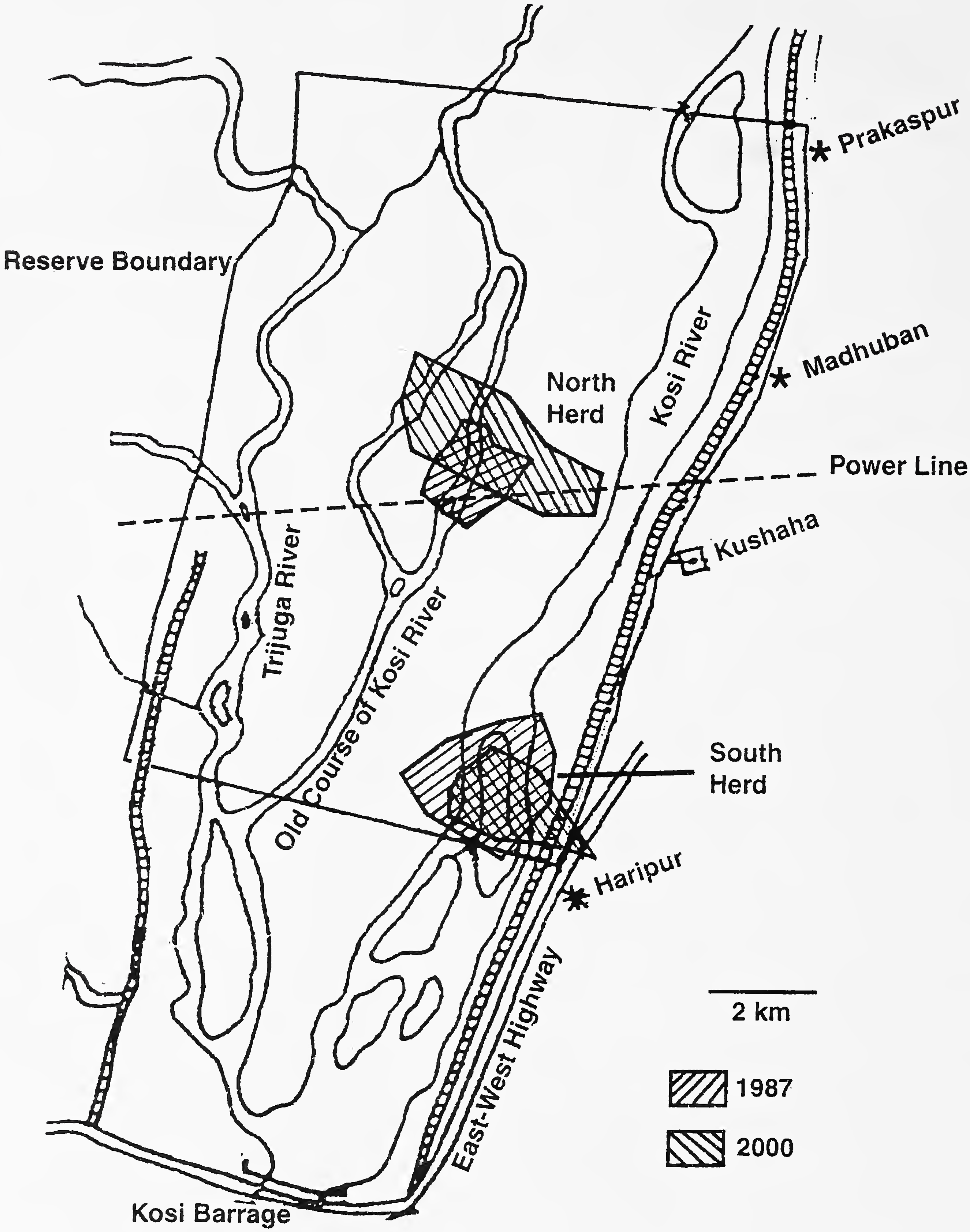

Fig. 2: Map of Kosi Tappu Wildlife Reserve, showing important locations around and within the boundaries

and *Acacia* make up the remainder. The vegetation was investigated by Dahmer (1978) and more extensively by Sah (1997); it is generally characteristic of riverine communities in the monsoonal climate of the Gangetic Basin (Stainton 1972).

The population of wild buffalo in Kosi Tappu has been censused numerous times and methods have been scrutinized because there are semi-feral as well as domestic buffalo that regularly backcrossed with wild bulls in the area (Mishra 1981, Shrestha 1981, 1997). Most of the censuses were conducted by local amateurs, or by biologists who spent only a week or two in Kosi Tappu, with little prior experience. There have been two longer studies: one in 1976 by Dahmer (1978) for one year, and the other by Heinen (1993a) from 1986 to 1988 covering 1.5 years. Heinen and Singh (*in press*) repeated the census in 2000, allowing for comparisons of population structure and growth rates over a 24-year period. Both the long-term studies considered flooding to be the major source of mortality and recommended translocations to Chitwan National Park. Heinen (1993a) considered the population not viable due to the probability of chance extinction (e.g. Goodman 1987). Census was completed from mid-February to early April, the season of grass cutting and burning, as the animals are more visible (Heinen 1993b) and also before the extreme heat of pre-monsoon set in, as the animals then become very inactive during the day.

The studies of Dahmer (1978), Heinen (1993a), and Heinen and Singh (*in press*) are considered to be the most definitive, as they were conducted by individuals who had spent extensive periods observing buffalo. However, given that backcrossing with wild males has been occurring in the region regularly since the malaria eradication in the 1950s (>40 years or >6 average buffalo generations, estimated at 6.5 years), one cannot be sure that animals counted as 'backcrossed' are not 'wild' in at least some cases. It also may not matter, for animals backcrossed for so many generations. An f-6 backcross would be 98.44% 'wild' based on nuclear DNA $100[1.0-0.5^6]$ (Falconer 1981). Such animals may be appropriate to include in a conservation breeding or translocation scheme, pending mitochondrial DNA analysis, provided that their appearance and behaviour are consistent with wild individuals. These issues are further addressed below.

Phenotypic Characteristics of Wild Buffalo

Wild buffalo go through changes in pelage with age. Young (< 6 months) calves are buff in colour, and begin to darken in the first year. They retain lighter coloration into the second year, but the coat continues to darken until the females achieve adult coloration by the third year. Thus, young, juvenile and adult females can be distinguished on the basis of coloration, and overall body and horn size. Adult coloration is very dark, with noticeable whitish markings in several places on the body. Wild buffalo have one or two white chevron marks on the underside of the neck. They also have white hocks, white tail tips, and fine white markings around the eyes and along the sides of the nose and mouth. The white markings tend to become more apparent in adults, may fade with advanced age, and are not necessarily visible on new calves. In all cases, they are visible on late first year calves. Young males can be distinguished from adults into the third and fourth years; they are noticeably smaller and the pelage retains the light coloration. Adult males at prime breeding age (> 4 years) tend to be very black, except for the whitish markings described.

The horns of wild buffalo form wide, upwardly sweeping semicircles and lack appreciable curvature in the lateral vertical plane. Horns begin to grow early in life and are apparent from a distance in all calves by the age of 6 months. Horns on very young calves extend horizontally from the skull, and lack any curl.

As in most Bovids, horns grow throughout life and can be used as a proxy for age among adults. Since growth rates can vary based on nutrition, sex and dominance status of individuals, the censuses did not record age estimates for the adults. On an average, among adults, females tend to have longer horns than males, but males tend to have much thicker horns. Thus, if the genitalia are not visible (typically the situation in the tall grasses of Kosi Tappu and other places in which purely wild stock are thought to occur), adults can be sexed by viewing the horns alone. Bulls are noticeably larger and have massive musculature. First and second year calves are difficult to sex because it is usually not possible to approach wild herds close enough to see the genitalia. Thus, sex classes were assigned for adults (> 2 years old) only.

In contrast, the typical 'river' breeds of domestic buffalo common in South Asia are generally much darker throughout life and show few to none of the white markings described above (see Cockrill 1974). Hall and Ruane (1993) recognized 74 breeds or varieties of domestic buffalo (fewer than for any other major domesticated mammal); some breeds retain light-colored tail tips and hocks. They are smaller and their horns are usually very small with noticeable curvature along both horizontal and vertical planes. Thus, pure domestic buffalo can be told from wild buffalo rather easily in Nepal and Central India. Some lesser-developed breeds of domestic buffalo, especially the 'swamp' breeds more common in Southeast Asia (Cockrill 1974), retain a few wild phenotypic characters and many of the buffalo residing in Kosi Tappu and elsewhere are known to be backcrosses. Thus, there are many individuals that look essentially wild, although they are not pure. Other field criteria are, therefore, needed for identifying wild stock.

Behavioural Characteristics of Wild Buffalo

Behavioural work is increasingly being studied in conservation biology (Caro 1998) and several behavioural characteristics were used to differentiate between wild and backcrossed buffalo here. The literature suggests that wild buffalo females remain in the herds in which they were born, while males leave their natal herds, usually in or before their third year (Heinen 1993a). Herding behaviour can vary seasonally in Australia (Tulloch 1978), but this was not observed in Kosi Tappu females. Members of wild herds of females and their dependent offspring (called 'mixed' herds by Heinen 1993a, not to be confused with 'backcrossed' female herds) are thought to be highly philopatric. Again, this is not so in the feral Australian population (Tulloch 1970).

Dahmer (1978) described two mixed herds in Kosi Tappu in 1976, the north and south herds, and Heinen (1993a) relocated those herds in 1986/88 in highly overlapping home ranges with those mapped by Dahmer. Heinen and Singh (2000) relocated the herds again in 2000 and found that their home ranges had not changed appreciably from the previous work in spite of the fact that the main channel of the Kosi River had changed course (Fig. 2). Animals in mixed herds showed a great deal of phenotypic uniformity compared to those in backcrossed herds, and herd members were always seen in close proximity to each other in all three Kosi Tappu studies. Backcrossed herds were seen in variable groupings, sometimes with as few as 6 animals. Mixed herds were always seen with one herd bull in attendance; backcrossed herds were also generally seen with an attendant wild bull, but not necessarily so. Several matings, between wild bulls and feral backcrosses, were observed in 1986, 1988 and 2000 (Heinen, unpublished field notes).

Herding behaviour in single adult males in Kosi Tappu is highly variable. Younger males (up to four years, as estimated from horn length and body size) were frequently seen in small groups with other males (6-8 animals), whereas

older males were frequently seen alone or in pairs. Both Dahmer (1978) and Heinen (1993a) recorded larger herds of older males on occasion, and thus, this behavior may vary seasonally or even daily. Herd bulls are those that accompany female herds, and no more than one at a time has been observed attending any herd, be it mixed (wild) or backcrossed.

Another aspect of behaviour that can be used as a clue in identification is flight distance. The mixed herds counted as wild in Kosi Tappu were extremely wary of any human approach, be it on foot, boat, elephant, or in vehicles, and all counts had to be made from relatively long distances (>150 m and usually more) using high powered binoculars. Females in Kosi Tappu have been observed frequently using 'phalanx' behaviour to protect calves from approaching humans prior to fleeing, also described for wild type buffalo in Sri Lanka (Eisenberg and Lockhart 1972). Phalanx behaviour is defined as adult females forming a lateral line, each facing the intruder, with calves interspersed between the adults. The backcrossed herds were all relatively easy to approach in vehicles (<100 m) and most of them allowed walking humans to approach within *c.* 150 m or less. They tended not to form a phalanx before fleeing. These subtle behavioural differences imply that the semi-feral backcrossed herds are rounded up by their owners on occasion, probably annually, to collect first year calves (especially males) for market (Dahmer 1978 and Heinen 1993a). Local villagers told us that these animals could be lured with salt licks like feral cattle (*Bos indicus*) breeding in the reserve.

Herd bulls tended to flee with their females on human approach. In contrast, single adult wild bulls allowed fairly close approach, frequently within 100 m or less. In all such cases, they faced the intruder and stood their ground. If a human came too close, the single adult bulls were likely to take one or several steps forward. Closer approach could presumably lead to a charge: several people have been injured or killed over the years in Kosi Tappu as a result of such encounters (Heinen 1993a). There are no records of wild or backcrossed females in Kosi Tappu charging humans directly.

Discussion

Mixed herds of wild buffalo with all the aforementioned phenotypic traits, with little visible phenotypic variability among individuals, a consistent herd structure (when not disturbed), using consistent home ranges over long periods of time, and with behavioural patterns that showed phalanx formation and intolerance to human approach were censused in three different seasons in Kosi Tappu from 1976 to 2000. All other females and calves that looked wild were considered backcrossed, in spite of the fact that some individuals in backcrossed herds displayed all phenotypic traits of wild buffalo, and all individuals in those herds displayed most traits (Table 2).

These methods *may* tend to undercounting of the wild buffalo. For example, a record sized female buffalo in Kosi Tappu was alive during Heinen's 1986-1988 study. The animal displayed all the traits of a wild buffalo, but was consistently seen with a herd in which some members lacked

Table 2
CENSUS RESULTS FOR BACKCROSSED BUFFALO HERDS CENSUSED DURING 2000

Herd	Adult Females	2nd year	1st year	Total
1.	25	9	6	40
2.	15	8	5	28
3.	8	1	3	12
4.	3	1	2	6
5.	4	2	1	7
6.	8	1	0	9
7.	5	2	2	9
8.	7	3	2	12
9.	5	2	1	8
Total	80	29	22	131

some wild phenotypic traits. Some females in this herd, for example, had distinctively more curl in the horns than was the case in the north and south herds, and some lacked a few of the characteristic white markings. Thus the female, which died of natural causes in 1994 and whose rack is now on display at the reserve headquarters, was not considered 'wild' (Heinen 1993a). Other methods, however, surely overcount wild buffalo. Suwal (1993) recorded a population of 158 in 1993, only 5 years after Heinen (1993a) recorded 93. This corresponds to a sustained population growth rate of >10% per year. Possible, but not likely for a large artiodactyl that generally produces a single offspring and usually calves biannually (Bronson 1989).

It is suspected that Suwal (1993) counted the large backcrossed herd seen regularly in the late 1980s (whose descendants were seen again in 2000; Herd 1 in Table 2) as 'wild' (the herd described above), and some members weren't based on phenotypic traits alone. Since females are thought to stay with their natal herds, it is likely that the matriarchal-line was of domestic origin and that the animals had been backcrossing with wild males for at least 6 generations. Since these animals acted essentially wild, and only a few minor phenotypic traits visible on some individuals were used to distinguish them from wild stock, it is possible that members of this herd could be used in a translocation program. However, that cannot be advised until mitochondrial DNA studies can be performed to determine how different the matriarchal-line really is from wild buffalo. Similarly, Chaudhary (1999) recorded a population of 174 wild buffalo in Kosi Tappu (in 1999), which is more likely than Suwal's (1993) estimate, but results from 2000 (Heinen and Singh, in press; Table 1) showed a decrease of 17% one year later in spite of many recent births. Evidence thus suggests that some studies were not long enough to allow researchers adequate

TABLE 1
POPULATION STRUCTURE OF WILD BUFFALO IN KOSI TAPPU RESERVE AND ANNUAL POPULATION GROWTH RATE

Year	Adult		2nd year	1st year	Total	Calves/ cows
	Male	Female				
1976	12	18	22	11	63	0.61
1987	32	29	14	16	91	0.55
1988	37	33	8	15	93	0.45
2000	56	53	17	19	145	0.36

r1 (1976 to 1987) = 0.033, r2 (1987 to 1988) = 0.022, r3 (1988 to 2000) = 0.037, r total (1976 to 2000) = 0.035. 1976 (Dahmer 1978), 1987, 1988 (Heinen 1993a) and 2000 (Heinen and Singh, in Press)

time to familiarize themselves with all the characteristics described above to identify the wild stock.

Evidence still suggests (Heinen 1993a) that there is little chance of domestic genes entering the population of wild buffalo because there is little chance of a domestic male competing with wild males and monopolizing breeding in a mixed herd. Heinen and Singh (2000) saw three domestic males in the Reserve in March 2000, but all were grazing near villages along the boundary and far from any mixed or backcrossed herds. No wild male counted in these studies had any phenotypic or behavioural traits suggesting that it was backcrossed. Furthermore, local buffalo owners informed us that they do not keep domestic males with their herds because wild males will attack them, and that their goal was to crossbreed their females with wild males, as the backcrossed males command higher prices when sold as draught animals. There is no evidence, therefore, that either backcrossed domestic, semi-feral, or feral males eventually enter the breeding population in Kosi Tappu. Shrivastava (*pers. comm.*) received similar information from the local buffalo owners around Kaziranga National Park, Assam during a recent study (September, 2000 to January, 2001). Thus,

the evidence suggests that both the reserves contain populations of pure wild buffalo in addition to semi-feral and backcrossed herds from which male calves are removed.

Conclusions

Hedges (1995) discussed the need for genetic studies, both mitochondrial and nuclear, to assess differences among the putative wild, wild type, feral, semi-feral and domestic buffalo that occur throughout tropical Asia. The first major genetic study of wild buffalo is currently underway in Kaziranga National Park (Dr. P. Malik *pers. comm.*). Even if appropriate mitochondrial genetic markers that differentiate wild from backcrossed matriarchal lines are isolated, detailed study should also be conducted at other sites because wild buffalo in Assam are noticeably larger and considered to be a distinct subspecies from those in Central India or Nepal. The available evidence suggests that animals counted as 'wild' in Kosi Tappu were truly so, and some females and calves recorded as 'backcrosses' may also be wild, or at least backcrossed for enough generations to make the distinction arbitrary. Thus, the methods described here are conservative indicators of what constitutes a wild buffalo.

This species is threatened with extinction throughout its range. I suggest that translocations can be planned with the current information by focusing on animals from herds that display all phenotypic and behavioural characteristics of the wild form. There are numerous reserves throughout lowland Nepal and North and Central India that are within the known historical range of the wild buffalo, but do not have populations. The Government of Nepal is considering a translocation proposal based on recommendations made from the identification criteria used here (Heinen and Singh, 2000). Furthermore, if future genetic work shows that some backcrossed feral females are essentially wild by nuclear DNA criteria, do not contain specific mitochondrial DNA markers that may render them less fit, and display most phenotypic and all behavioural traits consistent with wild buffalo, then such animals should also be considered for use in translocation projects.

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DISTRIBUTION PATTERNS, RELATIVE ABUNDANCE AND MANAGEMENT OF MAMMALS IN INDIRA GANDHI WILDLIFE SANCTUARY, TAMIL NADU, INDIA[1]

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(*With six text-figures*)

Key words: Western Ghats, Anaimalai hills, Indira Gandhi Wildlife Sanctuary, vegetation types, mammals, distribution patterns, niche separation, management

The study reports the results from systematic sampling and 6 years of incidental encounters with wild mammals in Indira Gandhi Wildlife Sanctuary, Anaimalai hills in the Western Ghats, Tamil Nadu, India. A total of 239 plots were laid along 38 transects in different vegetation types, covering a length of 200 km. Data was collected during transect walks by direct sightings, whereas the plots were searched for the presence of signs and tracks. Gaur, sambar and muntjac occurred with a higher frequency in rainforest, while chital and pig did so in other vegetation types. Elephants moved in the dry season to the wet western ranges and back in the wet season to the dry eastern ranges. Tiger had a higher frequency in the wet forests, while that of leopard was higher in the drier forest types. The dry forests at lower altitudes were occupied by the common palm civet, while the forested areas of higher altitudes were largely inhabited by brown palm civet, along with the small Indian civet which occurred commonly in the open areas. Malabar giant squirrel had a relatively higher frequency in other vegetation types than in the riparian forests of the eastern ranges, which were inhabited by grizzled squirrel. The dry forests at lower altitudes were occupied by bonnet macaque and Hanuman langur, whereas the wet forests of the higher altitude were occupied by lion-tailed macaque and Nilgiri langur. The wet ranges in the Sanctuary were characterized by fragmentation of rainforest, and the dry ranges had high biotic pressure. The implications of the mammalian distribution pattern and other biotic factors for the management of these hills are discussed.

Introduction

In southern India, wildlife habitats include the coastal plains, the Western and the Eastern Ghats, the central plains of northern Karnataka and Andhra Pradesh, the Deccan plateau, and the central plains of Tamil Nadu. These habitats differ in altitude, rainfall, terrain, soil structure, temperature and other factors. Among these, the most biodiverse is the Western Ghats, one of the hot spots of biodiversity in the world.

The Western Ghats run parallel to the west coast. Topographically, they can be divided into three zones: (a) the flat and narrow coast, (b) the rising ridge, a high rainfall area with evergreen and semi-evergreen forests, and (c) the eastern zone, with low rainfall, characterized primarily by scrub or deciduous forests. Kumar (1997) reports that of the nearly 15,000 species of flowering plants in India, 30 per cent occur in the Western Ghats, of which about 1,200 are endemic; of 158 species of fish in the Western Ghats, about 50 are endemic; of the 120 species of amphibians (total 205 in India), 90 are endemic; all of the 33 species of Uropeltids and 7 pit vipers of the Western Ghats are endemic (Inger and Dutta 1986); of about 500 species of birds, 15 are endemic (Daniels 1994). A large number of mammals, including the lion-tailed

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macaque (*Macaca silenus*), Nilgiri langur (*Presbytis johnii*), Nilgiri tahr (*Hemitragus hylocrius*), Malabar civet (*Viverra megaspila*), Malabar spiny dormouse (*Platacanthomys lasiurus*), Nilgiri marten (*Martes gwatkinsi*), Brown palm civet (*Paradoxurus jerdoni*), are endemic to the Western Ghats. Because of the uniqueness of this habitat, several areas in the Western Ghats have been brought under the 'Protected Area Network'. Johnsingh (1986) reported that of the total 78,387 sq. km area of the Western Ghats, 17,613 sq. km was brought under National Parks and Wildlife Sanctuaries. Some of the most important protected areas in the Western Ghats include Sharavathi Hills, Kudremukh National Park, Pushpagiri Wildlife Sanctuary, Brahmagiri Wildlife Sanctuary, Silent Valley National Park, Indira Gandhi Wildlife Sanctuary, Periyar Wildlife Sanctuary and Kalakad-Mundanthurai Tiger Reserve. Karanth (1992) has discussed in detail the factors that caused, and continue to cause, serious deterioration of forests in the Western Ghats in Karnataka. The same factors also explain the habitat deterioration in the states of Tamil Nadu and Kerala. They include the disturbance caused by human settlements, developmental projects, collection of forest produce, and hunting. The low lying areas of the Western Ghats were clear felled for rice and plantation crops, and the middle ranges were cleared for coffee and tea plantations. These agricultural activities also brought permanent settlers who required roads, bridges, electricity, schools and, hospitals. Since the Western Ghats receive high rainfall, the region has also become important for the construction of large and medium dams for power generation and irrigation. The forest produce collected from the Western Ghats includes cane, reeds, fruits and softwood for matchwood and plywood. Since all the above factors resulted in increased human activity, these may also have increased hunting in the region.

Indira Gandhi Wildlife Sanctuary (previously Anaimalai Wildlife Sanctuary) is one of the important ecoregions of the Western Ghats. Extensive research has been taken up on non-human primates in this Sanctuary (Kumar 1987, Menon and Poirier 1996, Singh *et al.* 1997a & b, 1998, 2000, Kumara *et al.* 2000a, Kumar *et al.* 2001). The effect of rainforest fragmentation on arboreal and terrestrial mammals has been reported by Kumar *et al.* (1995, 1998). Davidar (1978), and Mishra and Johnsingh (1998), undertook a thorough survey on the Nilgiri tahr in the Sanctuary. The above mentioned studies concentrated on particular species of mammals. There has been no study to document the overall distribution pattern of mammals, their occurrence in specific habitats, community structure and habitat preferences in the Sanctuary. The annual wildlife censuses carried out by the Forest Department, deal only with the animals sighted. They do not provide an assessment of habitats, or other conservation and management related issues. In this context, the present study was undertaken from June 1999 to July 2000.

Objectives

1. To document the distribution patterns and abundance of mammals in the various habitat types in the Sanctuary.
2. To document the presence of biotic pressures in different areas, and to assess whether these pressures have an impact on the occurrence of wild mammals.
3. To assess the effect of physical factors, including natural and man-made barriers, on the movement of large mammals.

Because of methodological problems, bats and terrestrial rodents were not included in this study.

Study Area

Anaimalai Ecosystem and Indira Gandhi Wildlife Sanctuary: Nearly 2,000 sq.

km of Anaimalai ecosystem includes the present Indira Gandhi Wildlife Sanctuary (Tamil Nadu), Parambikulam Wildlife Sanctuary (Kerala), Nelliampathy Hills (Kerala), parts of Palni Hills (Tamil Nadu) and, the Chinnar and Eravikulam Wildlife Sanctuaries (Kerala). These hills occupy a unique place in the Western Ghats, since the Ghats are widest (east to west) at this point. The present Indira Gandhi Wildlife Sanctuary and National Park is located at 10° 13' 08" to 10° 33' 27" N, and 76° 49' 02" to 77° 21' 07" E. In 1976, it was declared a Sanctuary encompassing 958 sq. km. In 1989, 108 sq. km of this Sanctuary was declared a National Park, which included Karian Shola, Grasshills and Manjampatty. The entire Sanctuary lies in the Western Ghats. It includes the low lying northern and eastern plains, two plateaus, and the high hills. The altitude ranges from about 275 m above msl in the Amaravathi Range and about 340 m above msl in the Pollachi Range, to nearly 2,500 m above msl in the Valparai Range. The rainfall varies from an annual average of 50 cm in the eastern side of the Sanctuary to about 500 cm in the western plateaus and slopes. The Sanctuary receives both southwest and northeast monsoon. However, the former is predominant in the western region and the latter in the eastern region.

Anaimalai Hills have a long history of forestry and related operations (Davidar 1987). Most of the area is characterized by steep hills and deep valleys. However, there are two large plateaus at Top Slip and Valparai. About 150 years back, these hills contained undisturbed and contiguous tracts of forests. The two plateau regions first came under horticulture and forestry.

a. **Teak Plantations in Top Slip Plateau**: Because of the medium elevation (< 700 m above msl) and medium rainfall (150 cm), this plateau primarily contained moist deciduous forests dominated by bamboo and teak. Vast stretches were opened up for teak plantations (Sundararaju 1987). Only a few stretches of mixed deciduous and bamboo forest were left, which have been serving as a crucial habitat for certain animals.

b. **Tea Plantations in Valparai Plateau**: Because of the higher elevation (>1,000 m above msl) and relatively higher rainfall (>250 cm), this plateau contained rainforests and semi-evergreen forests. The region was found highly suitable for growing tea and coffee (Congreve 1938). More than 20,000 ha of these forests around the present town of Valparai were leased to private companies, clear felled and converted into tea gardens, which brought a large number of people from the plains to the hills, where they became permanent settlers (now < 200,000).

c. **Hydel projects**: The third onslaught disturbing wildlife habitats critically is from the water harvesting schemes in this hill system. Although these hills receive high rainfall, the plains on the eastern side are very dry. It was realized that dams could be constructed at various places and the deep valleys would store an enormous amount of water for irrigation and power generation. Four water management schemes were, therefore, taken up in these hills. The Sholaiyar system includes smaller dams up hills such as Nirar, and larger dams including Sholaiyar, Parambikulam and Thunakadavu downstream. The second scheme includes the Kadamparai dam, Upper Aliyar and Lower Aliyar dams. On the eastern side, the two single dam schemes include Tirumurthy and Amaravathi. Power generation was taken up at Sholaiyar, Kadamparai, Navamalai and Sarkarpathi. A 49 km long contour canal was built to divert the Thunakadavu-Parambikulam water from the west to drain into Tirumurthy on the east.

In spite of these onslaughts on the forests, the Anaimalai Hills still retain some of the finest wildlife habitats in southern India. The hills are characterized by diverse forest types (Fig. 1). The lower elevation areas around Navamalai in Pollachi Range, and the areas of Amaravathi and Udumalpet ranges contain southern tropical

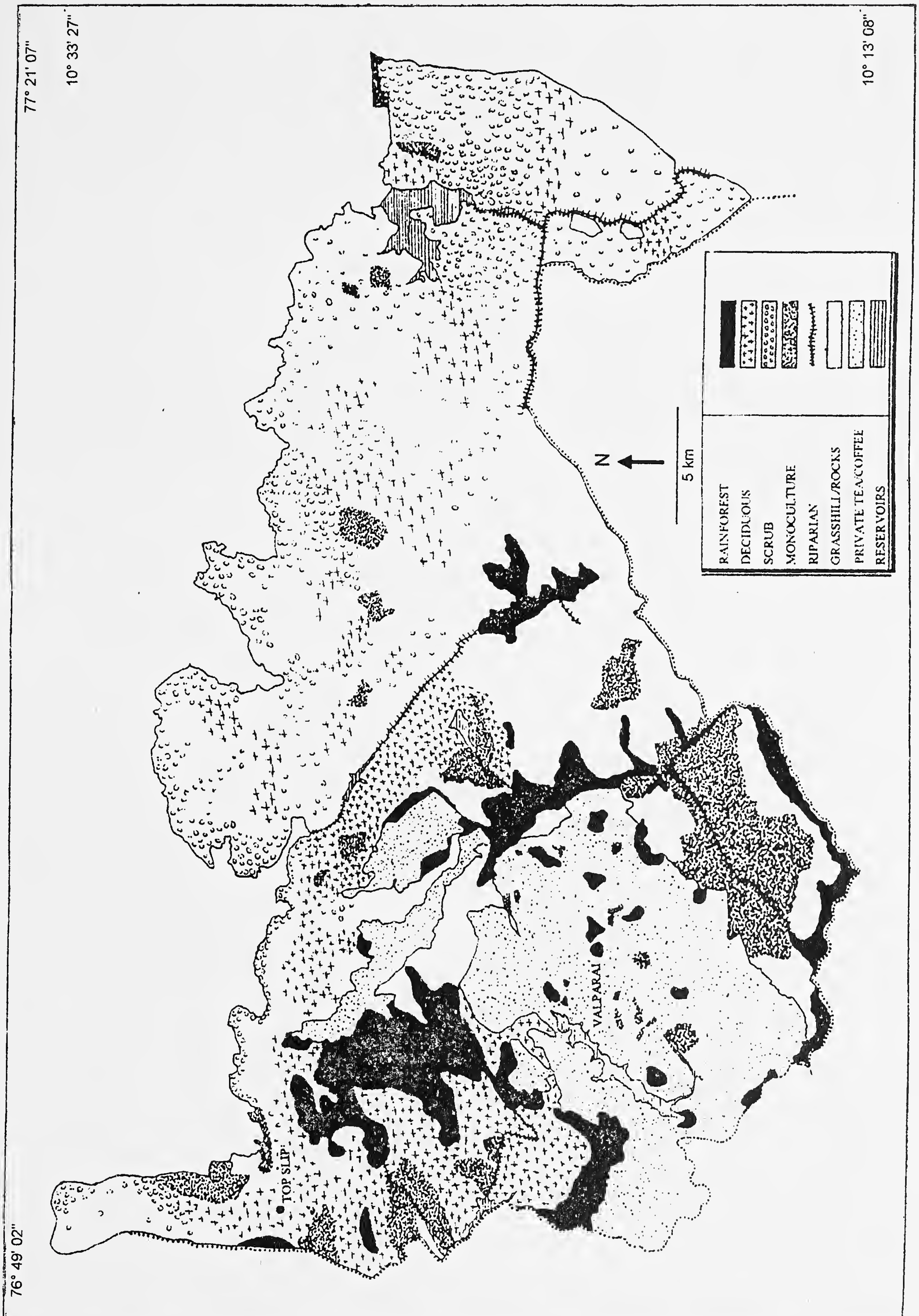


Fig. 1: Major vegetation types in Indira Gandhi Wildlife Sanctuary

thorn forests. The medium altitude ranges around Attakatti, Upper Aliyar, Kadamparai region and Top Slip region are characterized by deciduous forests. The upper ranges (>1,000 m above msl) around Valparai and even the middle elevation but high rainfall areas of Vargaliar-Panathiar region harbour rainforests. The mountain slopes (>1,800 m above msl) support typical shola forests, whereas the mountain tops are characterized by extensive stretches of grasslands, making it a typical montane habitat. Kumar *et al.* (1998) characterize the tropical wet evergreen forests in Indira Gandhi Wildlife Sanctuary as dominated by *Cullenia-Mesua-Palaquium*, *Hopea-Mesua-Artocarpus* and *Dipterocarpus-Anacolosa* associations; tropical montane forests dominated by *Gordonia-Michelia-Eugenia* species; mixed dry and moist deciduous forests dominated by *Tectona-Terminalia-Dillenia-Lagerstroemia* species; and thorn forests by several species of *Acacia*, *Zizyphus* and *Albizzia*.

This variety of habitats accounts for the diverse wildlife in the hills. The scrub and deciduous forests are home to most of the terrestrial mammals. The rainforests support a large variety of arboreal wildlife, and the peaks harbour typical montane species such as Nilgiri tahr. However, wildlife management in the Anaimalai Hills is a serious challenge. In addition to the past pressures, the present day problems include:

a. The management of wildlife in fragmented forests, especially in the rainforest fragments, and areas around the 35 tribal settlements in the Sanctuary.

b. The management of people: The tribes on the western side live primarily in rainforests and generally do not maintain livestock, while those settled in the dry forests on the eastern side maintain large stocks of cattle. Therefore, the grazing pressure is high on the eastern side. Similar biotic pressure is also faced from the villages outside the Sanctuary limits on the northern and eastern sides. Apart from the pressure of grazing by livestock, human pressures also visibly affect the Valparai plateau.

Methods

The two methods used were systematic sampling and incidental encounters. Systematic sampling was carried out by the line transect method and plot method.

Line Transect Method: Transects of varying length were laid in different habitat types (Fig. 2). The length of each transect was measured using a pedometer. All transects were not straight lines, due to the mountainous terrain and presence of several water reservoirs. Table 1 provides a summary of the length of transects in different forest ranges and vegetation types. A total of 38 transects were laid, covering a length of 200.47 km. A single transect could run through more than one vegetation type. All transects were walked at least once and most of them were repeated in wet and dry seasons. While walking a transect, the season, transect number, transect length, length of each vegetation type along a transect, mammalian species encountered, number of animals of each species sighted, distance of each animal from the starting point of the transect, and altitude were recorded. The data collected through this method were used for estimating encounter rates of various mammalian species. To some extent, this estimate was influenced by differences in visibility among various vegetation types. In the text, monoculture refers to teak and eucalyptus plantations inside the Sanctuary.

Plot Method: This was the second method employed in systematic sampling. Each plot was 3 m in width and 50 m in length. A plot was laid at every 500 m along the transect lines. The details of these plots are provided in Table 1. The plots were investigated only once, when information was recorded on season, vegetation type, signs of mammalian species (sightings,

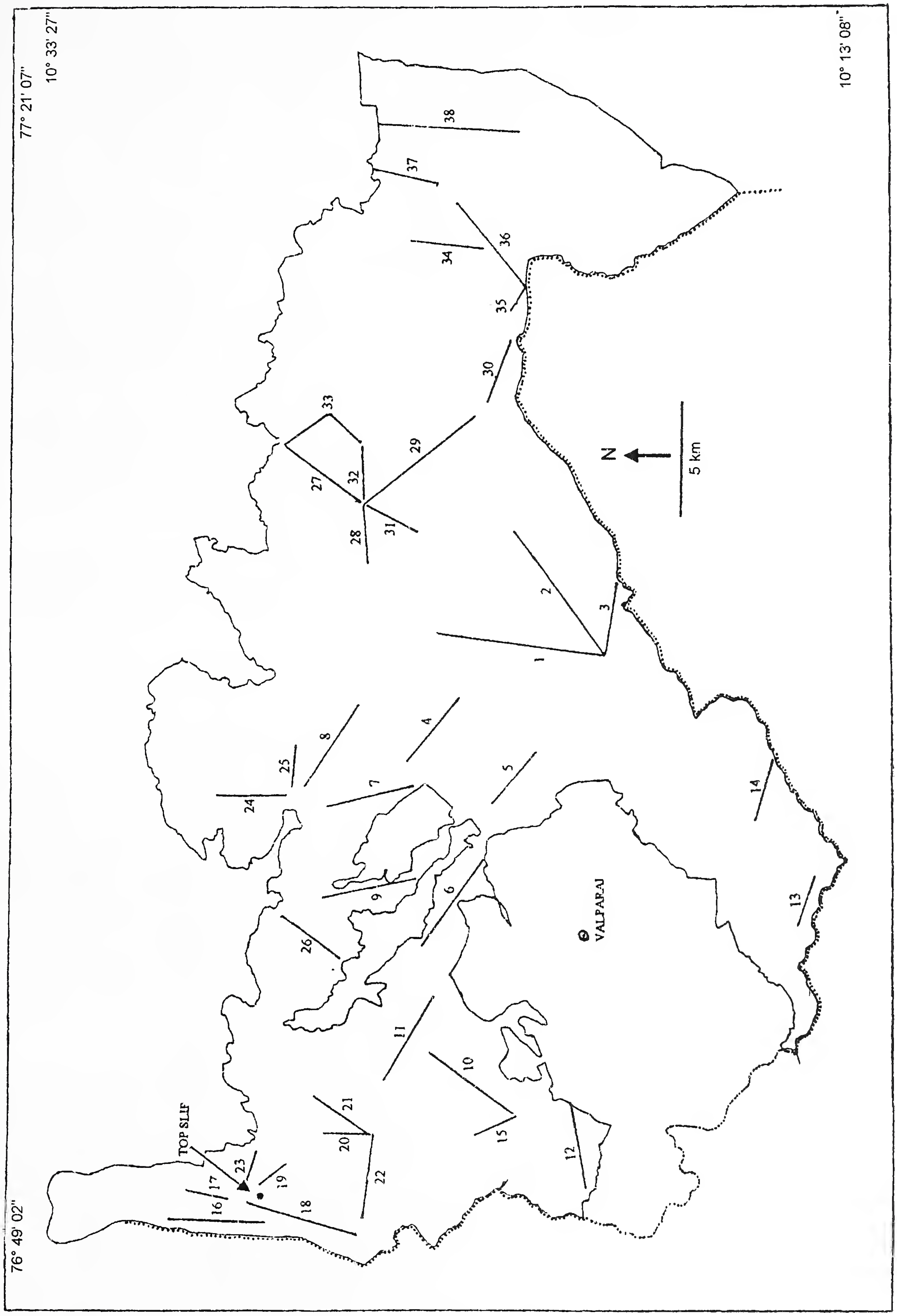


Fig. 2: Locations of line transects during the survey in Indira Gandhi Wildlife Sanctuary (see Appendix-II for names of places and distance of transects)

TABLE 1
DISTANCE COVERED (M) IN LINE TRANSECTS AND NUMBER OF PLOTS IN VARIOUS RANGES AND FOREST TYPES

Range	Rainforest	Deciduous	Riparian	Scrub	Grassland	Monoculture	Total
Valparai	27,900 (27)	9,650 (13)	3,900 (7)	1,750 (4)	10,800 (15)	1,700 (4)	55,700 (70)
Manampalli	27,434 (29)	11,176 (8)	2,400 (3)	330 (1)	-	1,200 (1)	42,540 (42)
Ulandy	8,467 (9)	7,490 (13)	-	1,700 (1)	-	4,218 (7)	21,875 (30)
Pollachi	1,640(1)	3,260 (7)	2,000 (2)	4,000 (4)	-	-	10,900 (14)
Udumalpet	2,930 (4)	2,903 (5)	14,413 (13)	29,522 (43)	4,532	842 (2)	55,142 (67)
Amaravathi	-	-	5,562 (7)	8,750 (9)	-	-	14,312 (16)
Total	68,371 (70)	34,479 (46)	28,275 (32)	46,052 (62)	15,332 (15)	7,960 (14)	2,00,469 (239)

Values in parentheses indicate number of plots

fresh signs of tracks, droppings, scrapes, feeding, digging, kills), altitude, dung deposits by livestock, woodcutting, poaching (snares, traps and encounters with poachers) and movement of people. Grazing was considered moderate if less than 60% plots per transect had cattle dung deposits, and severe if more than 60% had the same.

Woodcutting was also classified as rare or common, with similar percentage of plots per transect with stumps of cut wood. Average number of poaching signs per kilometre was calculated. The data collected through this method was used to record the absence or presence of wild mammals, as well as to assess the effect of biotic factors on occurrence of wild mammals.

Incidental Encounters (day and night): A systematic record has been kept on all mammalian species sighted in different parts of the Indira Gandhi Wildlife Sanctuary since July 1994. We also made several night trips by jeep and on foot in a few accessible places, primarily in the deciduous and rainforest. Such data have been used to indicate the presence and relative encounter rates, especially of some small mammals.

Regular *ad libitum* notes on physical barriers, and movement of people in the forest were also maintained from the information gathered from locals and forest staff. The data on the distribution of the Nilgiri tahr was collected through *ad libitum* sampling, since transect or plot method did not provide reliable information for this species.

Data analysis was carried out by applying the chi-square test for k proportions (Gibbons 1971).

RESULTS

Large Herbivorous Mammals

Occurrence in different vegetation types: Tables 2 and 3 present the data on encounter rates in transects and occurrence of signs in plots, respectively, on large herbivorous mammals in different vegetation types. The significance of difference for vegetation types was calculated through the chi-square test for k proportions for each species separately (Gibbons 1971). Except for muntjac (*Muntiacus muntjak*), the encounter rates of all animals differed significantly among various vegetation types (Table 2). In plots too, except for sambar (*Cervus unicolor*), and wild pig (*Sus scrofa*), the percent of occurrence of signs differed significantly among different vegetation types (Table 3). The direct sighting data reveal that these mammalian species occur with a higher frequency in relatively drier forests including monoculture. On the other hand, the

plot data shows more signs of these species in the rainforest, riparian forest and monoculture. Chital (*Axis axis*) was found to occur primarily in the scrub forest, with the exception of a small population in a deciduous forest at Top Slip. Contingency coefficient was also calculated for gaur (*Bos gaurus*), sambar, muntjac, chital and wild pig for their occurrence in rainforest and other vegetation types (combined) for the data presented in Table 3. A significant chi-square (χ^2 =20.99; df=4; p=0.01) revealed that, whereas gaur, sambar and muntjac had a higher frequency in rainforest, chital and wild pig had a higher frequency in other vegetation types.

Occurrence at different altitudes: Tables 4 and 5 present data on large herbivorous mammals at different altitudes. Except for muntjac, the encounter rates differed significantly in relation to altitude (Table 4), whereas sambar, chital and wild pig were sighted with a higher frequency at <500 m, elephant (*Elephas maximus*) and gaur were encountered more frequently at 500-1,500 m. However, the plot data (Table 5) revealed no significant

TABLE 2
NUMBER OF LARGE HERBIVOROUS MAMMALS ENCOUNTERED IN DIFFERENT VEGETATION TYPES IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	Rainforest	Deciduous	Riparian	Scrub	Grassland	Monoculture	Chi-square	p
Elephant	11 (0.16)	10 (0.29)	8 (0.28)	1 (0.02)	-	1 (0.13)	17.5	.01
Gaur	23 (0.34)	16 (0.46)	2 (0.04)	12 (0.26)	17 (1.11)	13 (1.63)	99.5	.01
Sambar	5 (0.07)	11 (0.32)	6 (0.10)	25 (0.54)	-	-	42.9	.01
Muntjac	9 (0.13)	5 (0.15)	2 (0.04)	1 (0.02)	-	1 (0.13)	7.1	NS
Chital	-	-	-	52 ((1.13)	-	-	235.4	.01
Wild pig	-	-	8 (0.14)	29 (0.62)	-	-	91.0	.01
Total distance of transects (km)	68.37	34.48	28.28	46.05	15.33	7.96		
Animal/km	0.70	1.22	0.92	2.61	1.1	1.88		

Elephant (*Elephas maximus*); Gaur (*Bos gaurus*); Sambar (*Cervus unicolor*); Muntjac (*Muntiacus muntjak*); Chital (*Axis axis*); Wild pig (*Sus scrofa*).
Values in parentheses indicate encounter rate per kilometre

TABLE 3
OCCURRENCE OF SIGNS OF LARGE HERBIVOROUS MAMMALS IN PLOTS IN DIFFERENT VEGETATION TYPES IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	Rainforest	Deciduous	Riparian	Scrub	Grassland	Monoculture	Chi-square	p
Elephant	21 (30.0)	22 (47.8)	19 (59.4)	26 (41.9)	4 (26.6)	8 (57.1)	11.5	.05
Gaur	33 (47.1)	12 (26.1)	6 (18.7)	4 (6.4)	6 (40.0)	7 (50.0)	32.5	.01
Sambar	39 (55.7)	17 (36.9)	14 (43.7)	23 (37.1)	1 (6.6)	5 (35.7)	6.5	NS
Muntjac	16 (22.8)	8 (17.4)	5 (15.6)	2 (3.2)	-	2 (14.3)	13.6	.05
Chital	-	2 (4.3)	3 (9.4)	10 (16.1)	-	1 (7.1)	15.7	.01
Wild pig	5 (7.1)	3 (6.5)	3 (9.4)	9 (14.5)	-	3 (21.4)	6.5	NS
Number of Plots	70	46	32	62	15	14		
Signs/plot	1.63	1.39	1.56	1.19	0.73	1.86		

Values in parentheses indicate occurrence of signs in per cent plots

TABLE 4
NUMBER OF LARGE HERBIVOROUS MAMMALS ENCOUNTERED AT DIFFERENT ALTITUDES (M) IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	<500	501-1000	1001-1500	>1500	Chi-square	p
Elephant	3 (0.09)	24 (0.22)	4 (0.10)	-	9.1	.05
Gaur	-	37 (0.34)	23 (0.55)	17 (0.28)	49.9	.01
Sambar	26 (0.80)	8 (0.07)	10 (0.24)	-	83.8	.01
Muntjac	1 (0.03)	13 (0.12)	2 (0.05)	-	5.5	NS
Chital	51 (1.57)	-	-	-	357.9	.01
Wild pig	33 (1.02)	4 (0.04)	-	-	180.4	.01
Total distance of Transects (km)	32.51	108.22	41.51	18.24		
Animals/km	3.51	0.79	0.94	0.93		

Values in parentheses indicate encounter rate per kilometre

TABLE 5
OCCURRENCE OF SIGNS OF LARGE HERBIVOROUS MAMMALS IN PLOTS AT DIFFERENT ALTITUDES (M) IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	<500	501-1000	1001-1500	>1500	Chi-square	p
Elephant	17 (45.9)	49 (44.5)	21 (36.8)	13 (37.1)	1.5	NS
Gaur	5 (13.5)	38 (34.5)	11 (19.3)	14 (40.0)	10.7	.05
Sambar	20 (54.1)	46 (41.8)	24 (42.1)	9 (25.7)	6.0	NS
Muntjac	3 (8.1)	15 (13.6)	12 (21.0)	3 (8.6)	4.3	NS
Chital	13 (35.1)	3 (2.7)	-	-	57.3	0.1
Wild pig	6 (16.2)	15 (13.6)	2 (3.5)	-	10.1	.05
Number of Plots	37	110	57	35		
Signs/plot	1.73	1.51	1.23	1.11		

Values in parentheses indicate occurrence of signs in per cent plots

difference in the distribution of elephant, sambar and muntjac with altitude. Chital and gaur occupied lower (<500 m) and higher (500-1,500 m) ranges respectively. Whereas the encounter data revealed significantly higher overall frequency of these species at <500 m (Table 4), this difference was not significant in the plots data (Table 5).

Large Carnivorous Mammals

Occurrence in different vegetation types and at different altitudes: Tables 6 and 7 present the data collected through plot method on large carnivorous mammals in relation to vegetation types and altitude respectively. Significant differences in the occurrence in relation to vegetation type and altitude were found only for bear (*Melursus ursinus*) and leopard (*Panthera pardus*). Bear occurred with a higher frequency in deciduous, riparian, scrub and monoculture forests, as against rainforest and grasslands (Table 6). The occurrence of leopard was greater in riparian, scrub and grassland and monoculture regions as compared to rainforest and deciduous forest. The overall occurrence of large carnivores was greater in scrub and monoculture areas. Whereas bear had a higher frequency at >500 m (Table 7), the leopard was abundant at <1,000 m. Contingency coefficient was also calculated for occurrence of leopard and tiger (*Panthera tigris*) in rainforest and other vegetation types (combined) for the data in Table 6. A significant chi-square (χ^2 =4.97; df=1; p=0.05) revealed that leopard and tiger occurred with higher

TABLE 6
OCCURRENCE OF SIGNS OF LARGE CARNIVOROUS MAMMALS IN PLOTS IN DIFFERENT VEGETATION TYPES IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	Rainforest	Deciduous	Riparian	Scrub	Grassland	Monoculture	Chi-square	p
Dhole	3 (4.3)	-	-	4 (6.4)	-	-	6.4	NS
Bear	4 (5.7)	12 (26.1)	5 (15.6)	13 (21.0)	-	3 (21.4)	13.6	.05
Leopard	4 (5.7)	1 (2.2)	3 (9.4)	7 (11.3)	2 (13.3)	5 (35.7)	16.1	.01
Tiger	6 (8.6)	2 (4.3)	1 (3.1)	-	-	1 (7.1)	7.1	NS
Jackal	-	-	-	1 (1.6)	-	-	2.9	NS
Number of Plots	70	46	32	62	15	14		
Signs/plot	0.24	0.33	0.28	0.40	0.13	0.64		

Dhole (*Cuon alpinus*); Bear (*Melursus ursinus*), Leopard (*Panthera pardus*); Tiger (*Panthera tigris*); Jackal (*Canis aureus*)
Values in parentheses indicate occurrence of signs in per cent plots

TABLE 7
OCCURRENCE OF SIGNS OF LARGE CARNIVOROUS MAMMALS IN PLOTS AT DIFFERENT ALTITUDES (M) IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	<500	501-1000	1001-1500	>1500	Chi-square	p
Dhole	2 (5.4)*	4 (3.6)	-	1 (2.9)	2.7	NS
Bear	2 (5.4)	27 (24.5)	8 (14.0)	-	16.3	.01
Leopard	7 (18.9)	12 (10.9)	1 (1.7)	2 (5.7)	8.9	.05
Tiger	1 (2.7)	6 (5.4)	1 (1.7)	2 (5.7)	1.7	NS
Jackal	-	1 (0.9)	-	-	1.2	NS
Number of Plots	37	110	57	35		
Signs/plot	0.32	0.45	0.18	0.14		

Values in parentheses indicate occurrence of signs in per cent plots

frequencies in other vegetation types and rainforest, respectively.

Small Mammals

Occurrence in different vegetation types: Tables 8 and 9 present the data on the occurrence of small mammals in different vegetation types. Mongoose and hare were encountered more in the drier forests than in the rainforest (Table 8). Whereas pangolin (*Manis crassicaudata*) and porcupine (*Hystrix indica*) were evenly distributed in all vegetation types (Table 9), mouse deer (*Tragulus meminna*) occurred with a higher frequency in rainforest and monoculture, and the small Indian civet (*Viverricula indica*) and brown palm civet were abundant in the rainforest and grassland. A contingency coefficient analysis was applied to the occurrence of small mammals in rainforest and other vegetation types (combined) for the data in Table 9. A significant chi-square (χ^2=8.65; df=3; p=0.05) revealed that mouse deer and civet occurred with a higher frequency in rainforest, while pangolin and porcupine had a higher frequency in other vegetation types.

Occurrence at different altitudes: Tables 10 and 11 present the data on the occurrence of small mammals at different altitudes. Only the hare had a significantly higher frequency at <1,000 m as against >1,000 m (Table 10). However, the data from plots gave non-significant difference in the occurrence of mouse

TABLE 8
NUMBER OF SMALL MAMMALS ENCOUNTERED IN DIFFERENT VEGETATION TYPES IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	Rainforest	Deciduous	Riparian	Scrub	Grassland	Monoculture	Chi-square	p
Mouse deer	1 (0.01)	1 (0.02)	-	-	-	1 (0.13)	8.4	NS
Mongoose	-	-	-	2 (0.04)	-	1 (0.13)	11.4	.05
Hare	-	2 (0.06)	-	5 (0.11)	-	-	12.3	.05
Total distance of transects (km)	68.37	34.48	28.28	46.05	15.33	7.96		
Animal/km	0.01	0.09	-	0.15	-	0.25		

Values in parentheses indicate encounter rate per kilometre

TABLE 9
OCCURRENCE OF SIGNS OF SMALL MAMMALS IN PLOTS IN DIFFERENT VEGETATION TYPES IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	Rainforest	Deciduous	Riparian	Scrub	Grassland	Monoculture	Chi-square	p
Mouse deer	8 (11.4)	2 (4.3)	-	-	-	1 (7.1)	12.9	.05
Civet	11 (15.7)	3 (6.5)	3 (9.4)	3 (4.8)	5 (33.3)	-	14.9	.05
Pangolin	2 (2.8)	4 (8.7)	-	-	-	1 (7.1)	9.5	NS
Porcupine	3 (4.3)	4 (8.7)	3 (9.4)	7 (11.3)	-	1 (7.1)	3.8	NS
Number of Plots	70	46	32	62	15	14		
Signs/plot	0.34	0.28	0.19	0.16	0.33	0.21		

Values in parentheses indicate occurrence of signs in per cent plots

deer, civet, pangolin and porcupine at different altitudes (Table 11).

Arboreal Mammals

Occurrence in different vegetation types and at different altitudes: Tables 12 and 13 present the data on the encounter rates of arboreal mammals in different vegetation types and altitudes. Significant differences were observed in the occurrence of all arboreal species inhabiting different vegetation types (Table 12). Malabar giant squirrel (*Ratufa indica*) had a higher frequency in rainforest, deciduous forest and monoculture; grizzled squirrel (*Ratufa macroura*) had a higher frequency in riparian forest; bonnet macaques (*Macaca radiata*) occurred only in deciduous and riparian forests; lion-tailed macaques had a higher frequency in the rainforest; Nilgiri langur in the rainforest and deciduous forest; and Hanuman langur (*Presbytis entellus*) in riparian forest. Significant differences were observed for all arboreal mammals in their occurrence at different altitudes (Table 13). Whereas Malabar giant squirrel was encountered with a higher frequency at altitudes of >500 m, the grizzled squirrel was encountered at <500 m only. Bonnet macaque and Hanuman langur occurred primarily at <500 m, whereas lion-tailed macaque and Nilgiri langur occurred at >500 m.

Distribution of mammals in wet and dry ranges

In Indira Gandhi Wildlife Sanctuary, the western ranges receive higher rainfall (>250 cm) than the eastern ranges (<75 cm). The distribution pattern of a few important prey and predator species was analyzed by combining the

data from plots in different ranges. Whereas gaur and mouse deer had a significantly higher frequency in the wetter ranges, the dry ranges had a higher frequency of chital (Table 14). Although tiger occurred with a higher frequency in the wet ranges, and leopard and dhole (*Cuon alpinus*) occurred with a higher frequency in the dry ranges, the difference in their distribution failed to reach the statistical significance (Table 14).

Table 10
NUMBER OF SMALL MAMMALS ENCOUNTERED AT DIFFERENT ALTITUDES (M) IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	<500	501-1000	1001-1500	>1500	Chi-square	p
Mouse deer	-	3 (0.03)	-	-	2.6	NS
Mongoose	2 (0.06)	1 (0.01)	-	-	5.9	NS
Hare	4 (0.12)	3 (0.03)	-	-	9.9	.05
Total distance of Transects (m)	32,505	1,08,217	41,511	18,236		
Animal/km	0.18	0.06	-	-		

Values in parentheses indicate encounter rate per kilometre

Table 11
OCCURRENCE OF SIGNS OF SMALL MAMMALS IN PLOTS AT DIFFERENT ALTITUDES (M) IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	<500	501-1000	1001-1500	>1500	Chi-square	p
Mouse deer	-	7 (6.4)	3 (5.3)	1 (2.9)	2.9	NS
Civet	2 (5.4)	10 (9.1)	6 (10.5)	7 (20.0)	4.6	NS
Pangolin	1 (2.7)	3 (2.7)	3 (5.3)	-	2.2	NS
Porcupine	6 (16.2)	8 (7.3)	3 (5.3)	1 (2.3)	5.5	NS
Number of Plots	37	110	57	35		
Signs/plot	0.24	0.25	0.26	0.26		

Values in parentheses indicate occurrence of signs in per cent plots

Table 12
NUMBER OF ARBOREAL MAMMALS ENCOUNTERED IN DIFFERENT VEGETATION TYPES IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	Rainforest	Deciduous	Riparian	Scrub	Grassland	Monoculture	Chi-square	p
Giant squirrel	56 (0.82)	21 (0.61)	8 (0.14)	-	-	4 (0.50)	94.9	.01
Grizzled squirrel	-	-	6 (0.11)	-	-	-	37.7	.01
Bonnet macaque	13 (0.19)	136 (3.94)	69 (2.44)	25 (0.54)	-	-	1657.6	.01
Lion-tailed macaque	93 (1.36)	-	-	-	-	-	335.2	.01
Nilgiri langur	345 (5.05)	147 (4.26)	-	-	-	17 (2.14)	284.4	.01
Hanuman langur	-	19 (0.55)	97 (3.43)	30 (0.65)	-	-	1295.7	.01
Total distance of transects (km)	68.37	34.48	28.28	46.05	15.33	7.96		
Animal/km	7.41	9.37	6.37	1.19	-	2.64		

Giant squirrel (*Ratufa indica*); Grizzled squirrel (*Ratufa macroura*); Bonnet macaque (*Macaca radiata*); Lion-tailed macaque (*M. silenus*); Nilgiri langur (*Presbytis johnii*); Hanuman langur (*P. entellus*)
Values in parentheses indicate encounter rate per kilometre

TABLE 13
NUMBER OF ARBOREAL MAMMALS ENCOUNTERED AT DIFFERENT ALTITUDES (M) IN INDIRA GANDHI WILDLIFE SANCTUARY

Species	<500	501-1000	1001-1500	>1500	Chi-square	p
Giant squirrel	-	47 (0.43)	32 (0.77)	3 (0.05)	50.1	.01
Grizzled squirrel	6 (0.18)	-	-	-	32.3	.01
Bonnet macaque	123 (3.78)	94 (0.87)	26 (0.62)	-	1016.2	.01
Lion-tailed macaque	-	87 (0.80)	6 (0.14)	-	110.5	.01
Nilgiri langur	-	358 (3.31)	132 (3.18)	19 (1.04)	82.8	.01
Hanuman langur	127 (3.91)	19 (0.18)	-	-	2048.4	.01
Total distance of Transects (km)	32.51	108.22	41.51	18.24		
Animal/km	7.87	5.59	4.72	1.21		

Values in parentheses indicate encounter rate per kilometre

An analysis was specifically attempted for the occurrence of elephants in the wet and dry ranges during wet (June-November) and dry (December-May) periods (Table 15). The data clearly indicated that the elephants occurred with a higher frequency in the wetter ranges of the west during the dry season and in the drier ranges of the east during the wet season. The reliability of the data was indicated by the overall occurrence of elephants in 41.5 and 42.8 % plots in wet and dry season respectively.

TABLE 14
OCCURRENCE OF SIGNS OF MAMMALIAN SPECIES IN PLOTS IN WET AND DRY RANGES OF INDIRA GANDHI WILDLIFE SANCTUARY

Species	Wet ranges	Dry ranges	Chi-square	p
	Prey species			
Gaur	60 (42.2)	8 (8.2)	32.7	.01
Sambar	64 (45.1)	35 (36.1)	1.9	NS
Muntjak	22 (15.5)	11 (11.3)	0.8	NS
Mouse deer	10 (5.6)	1 (1.0)	4.7	.05
Chital	3 (2.1)	13 (13.4)	11.8	.01
Pig	10 (7.0)	13 (13.4)	2.7	NS
Porcupine	8 (5.6)	10 (10.3)	1.8	NS
Signs/plot	177 (1.25)	91 (0.94)		
	Predators			
Tiger	8 (5.6)	2 (2.1)	1.8	NS
Leopard	10 (7.0)	12 (12.4)	1.9	NS
Dhole	2 (1.4)	5 (5.1)	2.8	NS
Signs/plot	20 (0.14)	19 (0.19)		
Number of Plots	142	97		

Values in parentheses indicate occurrence of signs in per cent plots

Incidental encounters of some mammalian species

Small mammals and Nilgiri tahr: The data on our long term but incidental recordings of small mammals and Nilgiri tahr obtained through night drives and walks of known distance is presented in Table 16. The sighting frequency was converted to encounters per kilometre. Many small mammals were found only in some characteristic habitat types in the Sanctuary, but the data table in the end presents the overall encounter rates for the entire Sanctuary. Slender loris (*Loris tardigradus*) was seen only in the drier regions of the Sanctuary, with an overall encounter rate of 0.04 animals/km. Flying squirrel (*Petaurista petaurista*) and

TABLE 15
OCCURRENCE OF SIGNS OF ELEPHANTS IN PLOTS IN WET AND DRY RANGES ACROSS SEASONS IN INDIRA GANDHI WILDLIFE SANCTUARY

Ranges	Wet season	Dry season	Chi-square	p
Wet	118 (35.6)	24 (58.3)	4.3	.05
Dry	58 (53.4)	39 (33.3)	3.8	.05
Overall	176 (41.5)	63 (42.8)	.003	NS

Values in parentheses indicate occurrence of signs in per cent plots

TABLE 16
NUMBER OF SOME SMALL MAMMALS ENCOUNTERED PER KILOMETRE IN DIFFERENT AREAS IN INDIRA GANDHI WILDLIFE SANCTUARY

Area	Loris	Flying squirrel	Mouse deer	Nilgiri marten	Stripenecked mongoose	Brown palm civet	Small Indian civet	Common palm civet	Small cats	Distance covered (km)
Amaravathi-Chinnar	0.21	-	-	-	-	-	-	-	-	24
Contour Canal-Navamalai	0.12	-	0.05	-	-	-	0.02	0.11	0.01	186
Top Slip	0.25	0.07	-	-	-	-	-	0.05	-	12
Aliyar-Kadamparai Gate	0.05	-	-	-	-	-	-	0.27	-	120
Upper Aliyar-Vandal	-	-	0.003	-	-	-	0.01	0.01	0.003	324
Manampalli-Panathiar-K.gate-Waterfall	-	-	0.14	-	-	-	-	0.19	-	42
Andiparai-Iyerpadi-Urlikal	-	0.27	0.13	0.04	0.10	0.18	-	-	0.01	70
Puthuthotam	-	1.92	0.27	-	0.12	0.20	0.07	-	-	40
Overall	0.04	0.12	0.03	0.003	0.01	0.04	0.01	0.08	0.004	
Number of animals seen	37	99	28	3	12	13	10	67	4	818

Loris (*Loris tardigradus*); Flying squirrel (*Petaurista* sp.); Nilgiri marten (*Flavigula gwatkinsi*); Stripenecked mongoose (*Herpestes vitticollis*); Brown palm civet (*Paradoxurus jerdoni*); Small Indian civet (*Viverricula indica*); Common palm civet (*Paradoxurus hermaphroditus*)

TABLE 17
OCCURRENCE OF SIGNS OF BIOTIC FACTORS IN TRANSECTS IN DIFFERENT RANGES IN INDIRA GANDHI WILDLIFE SANCTUARY

Range	No. of transects	Grazing		Woodcutting	
		Moderate	Severe	Rare	Common
Valparai	9	1 (14.3)	1 (14.3)	5 (55.5)	1 (11.1)
Manampalli	6	2 (33.3)	0	4 (66.7)	1 (16.7)
Ulandy	7	0	0	1 (14.3)	0
Pollachi	3	1 (33.3)	2 (66.7)	2 (66.7)	0
Udumalpet	9	2 (22.2)	7 (77.8)	3 (33.3)	1 (11.1)
Amaravathi	3	0	3 (100)	0	2 (66.7)
Chi-square		4.29	23.35	8.95	7.63
p		NS	.01	NS	NS

Values in parentheses indicate occurrence of signs in percent plots

mouse deer were met with encounter rates of 0.12 and 0.03 animals/km respectively, with a considerably higher rate in the wetter forests. Nilgiri marten and stripenecked mongoose (*Herpestes vitticollis*) (0.003 and 0.01 animals/km respectively) were also found only in the wet regions. The distribution of different species of civets showed strong ecological correlates. In the lower altitude and relatively drier forests, common palm civet and small Indian civet were sympatric, the former being more common (Fig. 3). In the higher altitude and wetter regions, brown palm civet and small Indian civet were sympatric. The brown palm civet was more common in the forested regions, whereas the small Indian civet preferred relatively open areas such as tea estates.

Fig. 4 presents the information on the distribution of Nilgiri tahr in the Sanctuary (Appendix-III). The Nilgiri tahr was found mainly in the rocky terrain and hilltops from 500 m (3 HP on Aliyar-Valparai Road) to about 2,500 m (Akkamalai ridge) and occurred in both wet and dry regions. The presence of tahr could be classified into eight distinct populations in the Sanctuary. Populations I (8 animals), III (14 animals) and IV (indirect evidence of presence) appeared to be isolated in the Sanctuary, but it is possible that they are continuous with populations in Parambikulam Wildlife Sanctuary in Kerala. These areas need further exploration. Populations VI (71 animals sighted at one time) and VIII (2 animals) were again isolated populations. Population VI at Pachchapalmalai appeared to be a biologically self-sustaining population, whereas Population VIII probably had only a few animals. Two populations, i.e. Population II (39 animals) and Population V (32 animals) were distributed over relatively large areas with probably low densities. A relatively high density (191 animals sighted at one time) was observed in Population VII (211 animals) in the Akkamalai-Grasshills region, which is continuous with Eravikulam Wildlife Sanctuary in Kerala, making this population contiguous with that in Kerala.

Mammals sighted in tea gardens: Many private tea gardens in the Valparai plateau still retain fragments of rainforest (Fig. 1) and also have areas under eucalyptus plantations. Although line transects and plots were not laid in these forests fragments during the present study all incidental encounters with wild mammals in the private estates and forests were recorded. The number of encounters with wild mammals was as follows: elephant herds (22), gaur herds (63), sambar (88), muntjac (176), mouse deer (16), wild pig (3), porcupine (3), bear (13), tiger (1), leopard (14), dhole packs (27), jackal (*Canis aureus*) (4), leopard cat (*Felis*

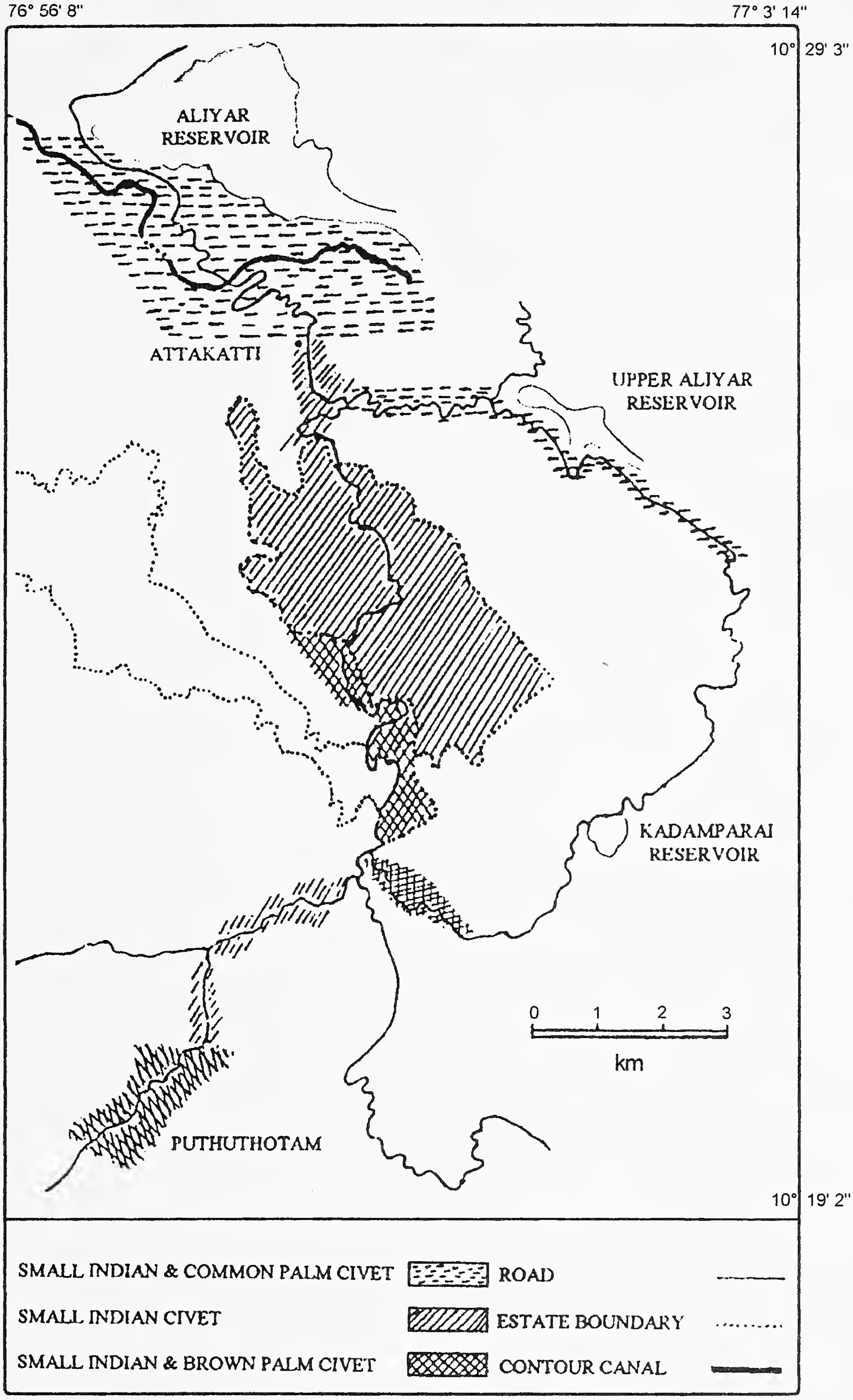


Fig. 3: Distribution of civets in Indira Gandhi Wildlife Sanctuary and private tea gardens around Aliyar-Valparai Road

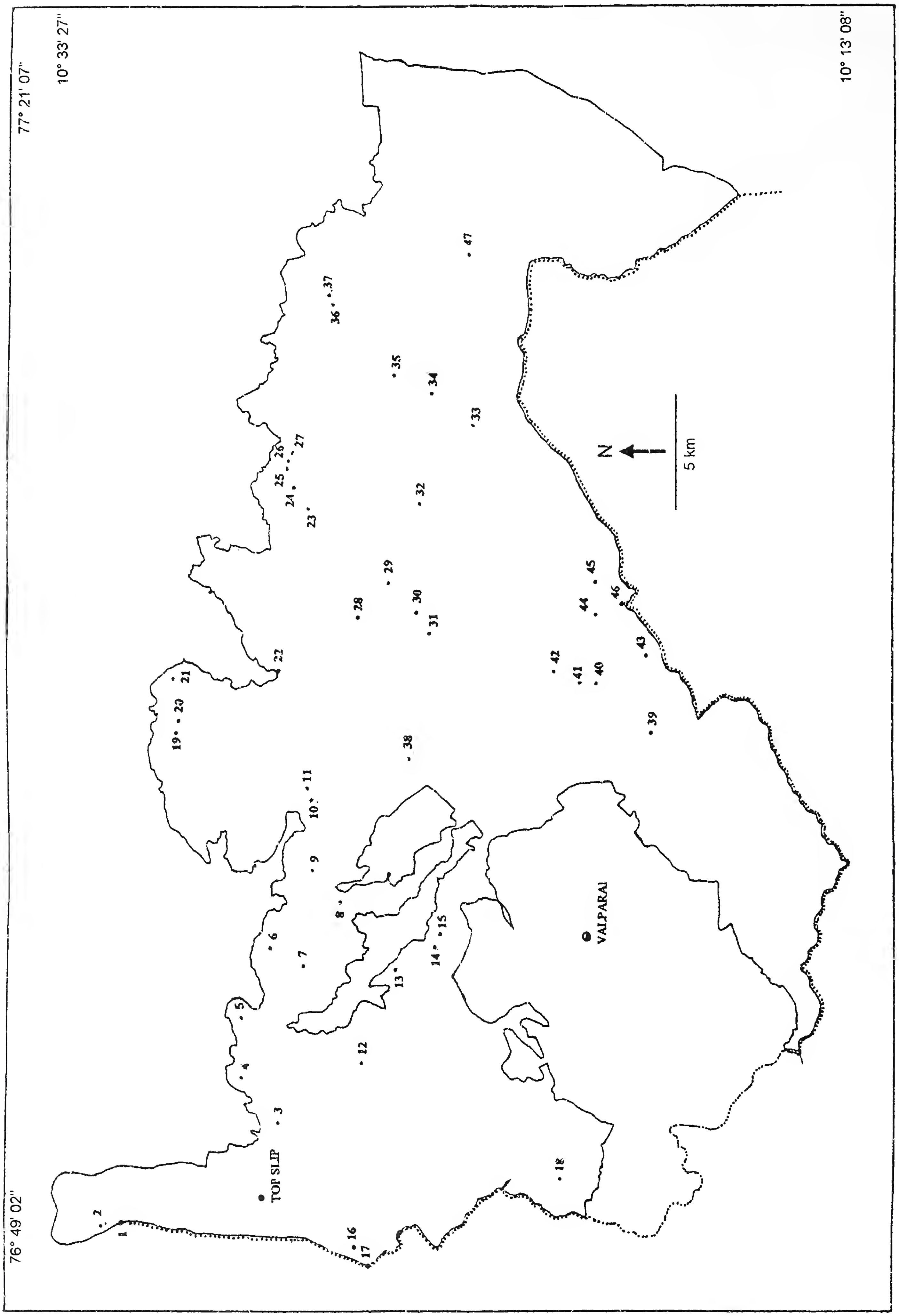


Fig. 4: Populations of Nilgiri Tahr in Indira Gandhi Wildlife Sanctuary (see Appendix-III for names of places)

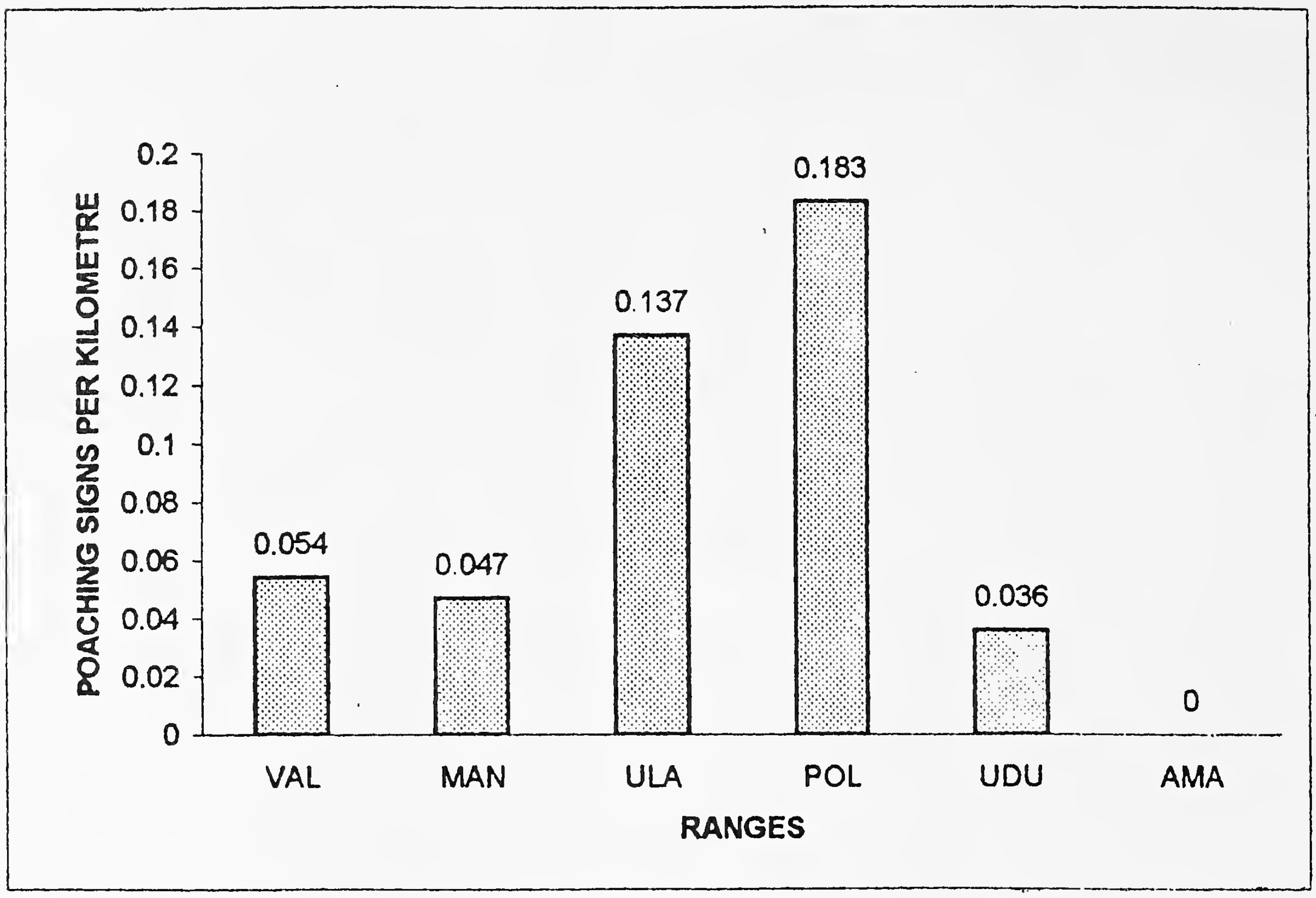
bengalensis) (3), unidentified cat (1), stripe-necked mongoose (23), brown palm civet (8) and small Indian civet (33). In addition, several fragments harbour resident populations of lion-tailed macaque, Nilgiri langur, Malabar giant squirrel and flying squirrels (*Petaurista* sp). The small and arboreal mammals are resident in the forest fragments used by the larger terrestrial animals to move between Manampalli/ Shekalmudi and Akkamalai/Iyerpadi forests.

Biotic factors and barriers for dispersal

Biotic pressures on the Sanctuary: Table 17 presents data on grazing by the livestock and woodcutting by people in the Sanctuary. Statistically significant differences were observed for severe grazing in various forest ranges. High grazing pressure was observed in the drier ranges including Pollachi, Udumalpet and Amaravathi. Grazing by the livestock was not observed in Ulandy, and the pressure was not severe in Valparai and Manampalli ranges. Although woodcutting was more common in Amaravathi, the chi-square test did not show any significant difference among the various forest ranges. Fig. 5 presents the data on signs of poaching attempts per kilometre in different ranges. More snares and traps were found in Ulandy and Pollachi ranges as compared to other ranges. No such signs were found in Amaravathi range. Traps of different sizes made out of wooden stumps and bamboo were found during the study. Snares made out of plastic wires and wire mesh were also found. Most of these traps were placed in forest fringes along estates or village boundaries. The traps were also found near water holes and in the regularly used animal tracks. Over the years we observed occasional stealing of kills made by dhole and leopard in some tea estates bordering forest areas. Analysis was also carried out for the occurrence of all mammalian species in per cent plots with relation to biotic factors. With the exception of gaur, the distribution of no other species was found to be in any way influenced by the biotic factors, the details of these analyses are not presented here. Gaur was found to occur in 41.3, 8.0 and 0 percent plots, in plots with no grazing, moderate grazing and severe grazing, respectively. A chi-square analysis (χ^2=39.5; df=2; p=0.01) revealed the above frequencies of occurrence of gaur in plots to differ significantly.

Barriers for dispersal of mammals: The barriers (Fig. 6) for dispersal of mammals in Indira Gandhi Wildlife Sanctuary were both natural and man-made. The natural barriers were hills with steep slopes. Man-made barriers included tea estates, hydel projects, human settlements and various roads. The most prominent barrier was the road between Aliyar and Valparai. Not only is the traffic heavy on this road, but the terrain from Aliyar up to Iyerpadi forest makes the movement of animals between west and east difficult. South of Iyerpadi forest, the Valparai plateau area was cultivated for tea. The western and eastern sides of this road have become two separate regions with a small corridor between them at Iyerpadi and Andiparai forests. Aliyar, Upper Aliyar and Kadamparai system of reservoirs further separate the eastern and western ranges.

In the eastern parts of the Sanctuary, a large number of tribal settlements with domestic cattle were an obstruction to the free movement of mammals. As may be seen in Fig. 6, the tribal settlements in the eastern region were not only more numerous than in the western region, they were also clustered, most of them with their livestock were concentrated in the drier parts of the Sanctuary. Although the average number of households per settlement (about 23) was the same in the wet and the dry regions, the livestock averaged 3.9 animals per household in the dry region against 0.3 animals in the wet region. In addition, there were several colonies for the staff of the Tamil Nadu Electricity Board. The concentration of these colonies, movement of personnel, vehicles, and cattle was primarily in



(VAL - Valparai, MAN - Manampalli, ULA - Ulandy, POL - Pollachi, UDU - Udumalpet, AMA - Amaravathi)

Fig. 5: Poaching signs per kilometre in different ranges

the drier regions at Attakatti, Upper Aliyar, Navamalai, and Kadamparai. Such movement is much less at Manampalli Power House in the wetter region. Due to the presence of steep hills and relatively dry scrub forests, the availability of forage and space for movement for wild animals was restricted to a few narrow valleys and streambeds. Most of these areas were also utilized by locals and their livestock, creating human-animal conflicts. In the western region, the southern forests of Valparai range were totally cut off from the northern forests of Manampalli and Ulandy ranges due to tea gardens in the Valparai plateau. Sholaiyar and Parambikulam reservoirs have cut off the adjoining forest areas.

Discussion

Methodological issues

In the present study, line transect method based on direct sightings, and plot method based on indirect evidence, were used to complement each other. The results obtained through these two methods reflect upon the relative efficacy of these methods for one time survey of mammalian species. As far as vegetation types and distribution of mammals was concerned, the two methods brought out two different distribution patterns. On the basis of direct sightings, large herbivorous mammals appeared to have a higher frequency in drier forests. However, the plot method indicated higher occurrence, except for elephant and wild pig, of these species in rainforests. Likewise, the encounter rates of these species were higher at lower altitudes (with dry and open forests), but the indirect evidence from plot method showed an even distribution at different altitudes. It is, therefore, very clear that visibility, determined by the nature of vegetation, is a limiting factor in the direct sighting method. Direct sightings have proved to be efficient in determining abundance and density of wild animals, but perhaps only when one repeatedly walks on transects. We propose that for a quick

appraisal of mammalian distribution and relative abundance in a single survey, the plot method is more useful.

Habitat types, mammalian distribution and niche separation

The 958 sq. km area of Indira Gandhi Wildlife Sanctuary is characterized by a variety of habitat types. A unique feature of the Sanctuary is the presence of the Western Ghats ridges and plateaus receiving heavy monsoon, and the eastern slopes and plains in the rain shadow. These rainfall patterns have led to the growth of forests that include scrub jungles, deciduous forests, rainforests, shola and grasslands. These habitat types in turn support a variety of wild mammalian species that inhabit all or most habitat types, or are typical only to some habitat types. Some of the large herbivorous mammals such as elephant, gaur and sambar, that are more or less generalized feeders, occur in almost all habitats. Elephant, the most generalized feeder, even moves from wet ranges during the dry season to dry ranges during the wet season. On the other hand, typical niches such as scrub jungles of plains and rocky faces of mountains are occupied by chital and Nilgiri tahr respectively. The Nilgiri tahr populations described in this paper are similar to those described earlier (Mishra and Johnsingh 1998).

Similar ecological separation in closely related species can be seen in small mammals too. The common palm civet inhabiting dry forests of the lower altitudes is replaced by the brown palm civet in the wetter forests at higher altitudes. The small Indian civet also occurs at higher altitude, but is usually found in open areas such as tea gardens, and hence is separated from the forest dwelling brown palm civet.

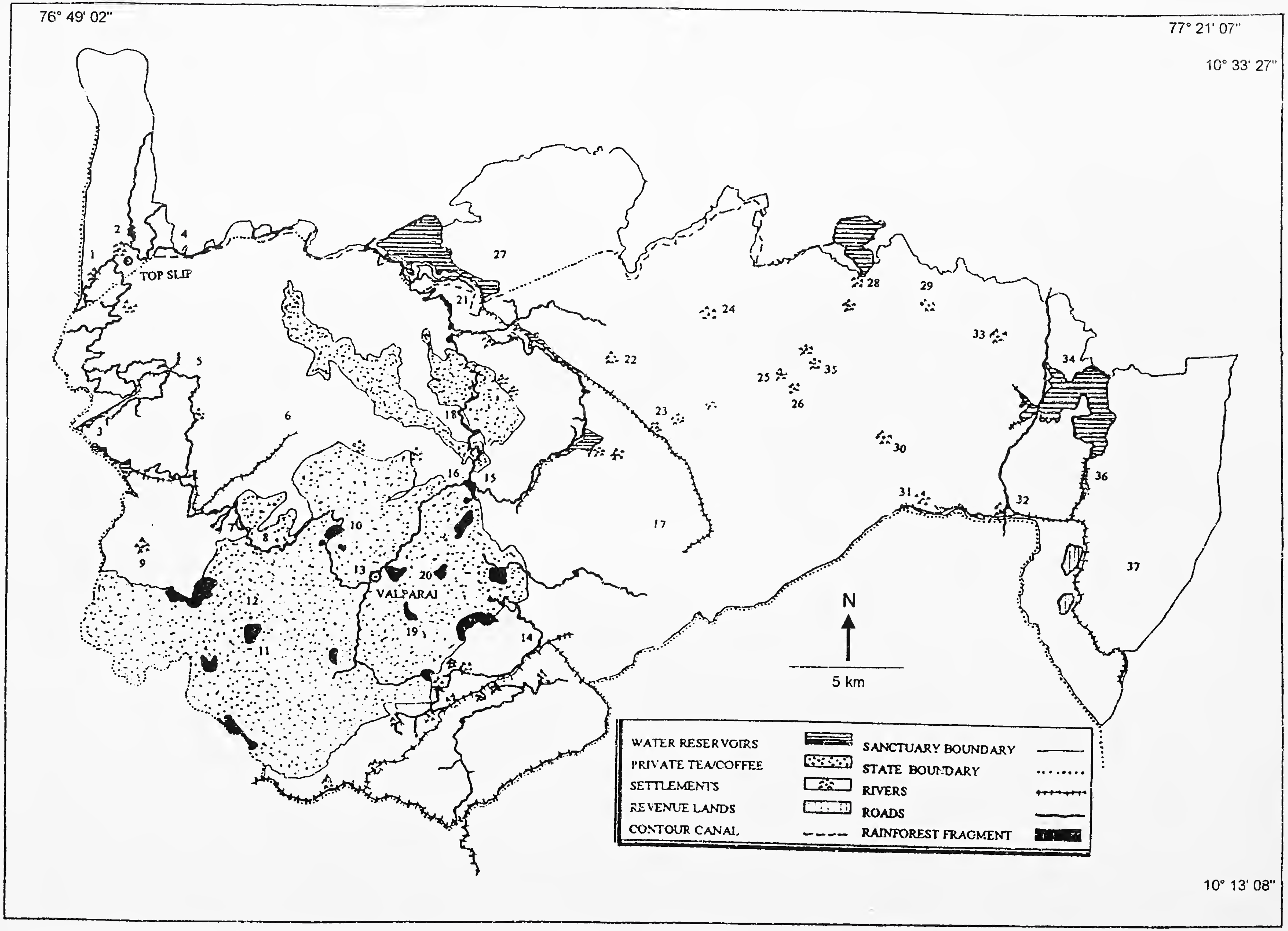
The most remarkable case of niche separation was observed in arboreal mammals. The Malabar giant squirrel, occurring at a high frequency in many habitat types, is seen at a significantly lower frequency in the riparian forest at <1,000 m. The riparian forests in the eastern part of the Sanctuary are occupied by the grizzled squirrel. In the rainforests at >1,000 m, lion-tailed macaque and Nilgiri langur are sympatric, but Nilgiri langur also inhabits moist deciduous forests. In the dry forests at lower altitudes, the riparian forest is primarily occupied by the Hanuman langur, while deciduous and scrub forests are inhabited by the bonnet macaque. Though not as clear cut as in other taxa, a tendency towards niche separation may also be observed in large carnivores. Tiger and gaur is more abundant in the western regions, whereas leopard, dhole and chital are more abundant in the eastern ranges.

A higher frequency of most terrestrial mammals was observed in 'monoculture' as compared to other habitat types. This may be due to the fact that animals use the patches of teak plantations to move between different habitat types.

Biotic factors

Although there are biotic pressures in the form of grazing, woodcutting and poaching, these factors did not appear to influence the distribution and relative abundance of most wild mammals. However, grazing by the livestock appears to have significantly affected the occurrence of gaur. The present data, and also our observations of several years, show that gaur is almost absent from the areas grazed by livestock. In the entire eastern parts of the Sanctuary, gaur occurs only on some steep slopes or in some valleys, which are not grazed upon by the livestock. This pattern can be seen in the Navamalai-Contour Canal region. Gaur is frequently seen south of contour canal where the livestock is prohibited, but in the entire area north of the canal, which is grazed by cows and buffaloes, it has never been observed though some habitat is suitable for gaur. Similarly, in the upper Aliyar-Kadamparai-Vandal region, and also around tribal settlements in the eastern parts,

Fig. 6: Natural and man-made barriers for animal dispersal in Indira Gandhi Wildlife Sanctuary



1. Karian Shola, 2. Top Slip, 3. Perambikulam, 4. Sarkarpathi, 5. Varagaliyar, 6. Ayamgulam, 7. Manampalli P. House. 8. Urlikal, 9. Shekalmudi, 10. Varutparai, 11. Korangumudi, 12. Sholaiyar, 13. Valparai, 14. Cinnakallar, 15. Iyerpadi, 16. 36HP. 17. Akkamalai, 18. Andiparai, 19. Sirikundru, 20. Nadumalai, 21. Navamalai, 22. Mavidappu, 23. Karumutti, 24. Kulipatti, 25. Kurumalai, 26. Kottaiar, 27. Erumakandi, 28. Thirumurthy, 29. Isalthittu, 30. Attukudi. 31. Kodandur, 32. Chinnar Check Post, 33. Elumalaikovil, 34. Amaravathi, 35. Vandiar, 36. Thuvanam, 37. Varavandiodai

though a large area is relatively dry, it is still suitable for gaur in most places. The availability of natural fodder in these areas is evident from the fact that a large number of domestic animals graze here.

Management of wild mammals in Indira Gandhi Wildlife Sanctuary

The habitat types, distribution and relative abundance of mammals and the biotic pressures in Indira Gandhi Wildlife Sanctuary have implications for management.

Management in the wet western region: The main feature of the western ranges is the fragmentation of rainforest, and the presence of forest fragments in tea estates. In a detailed study of forest fragmentation and its effect on arboreal and terrestrial small mammals, Kumar *et al.* (1998) stated that several parameters related to these fragments influence the presence of mammals in different ways. The size of the fragments influenced the occurrence of arboreal mammals with lion-tailed macaques as the most affected. The loss of canopy contiguity directly affected the presence of the Nilgiri langur. The distribution patterns of rodents were influenced such that the forest fragments smaller in size and frequented by humans have become dominated by the commensal species. Spiny dormouse has disappeared totally from small fragments. According to Kumar *et al.* (1998), more than the size, it was the quality of a fragment that determined the occurrence of mammalian species. This observation has far reaching implications for the management of forests and wildlife in the western ranges of Indira Gandhi Wildlife Sanctuary. As mentioned in the results, the Valparai plateau is frequently used by small and large mammals to move between Manampalli/Urlikal/Shekalmudi and Nirar/Cinnakallar/Akkamalai areas. During these movements, the animals make use of the remaining forest fragments for forage and as shelter. Some of these very crucial private forest patches are at Varutparai, Puthuthotam, Sirikundru, Korangumudi, Nadumalai, and other smaller patches of vegetation along streams. The region being a plateau, the animals have probably historically used these areas for movement, and will continue to use them. It is, therefore, a must that these forest fragments, including monocultures of eucalyptus in some places, are paid special attention. Since these fragments also harbour arboreal mammals, special attention also must be paid to the type of vegetation around and inside these fragments. A plan can be developed to retain these fragments, improve the quality of vegetation and also to link them through stream corridors. This plan is workable and can be executed with the help of the management of tea estates, showing them that it is in their long-term interest if the private forest fragments are maintained and improved. If these fragments are removed or further degraded, man-animal conflict may only become severe, resulting in the loss of property and human lives due to the larger mammals.

Some rainforest areas such as Sankarankudi are underplanted with cardamom. Green and Minkowski (1977) stated that clearing the dense undergrowth vegetation destroys the intricate network of roots supplied by the smaller plants rendering the soil in cardamom fields more vulnerable to erosion. As the removed vegetation no longer contributes to leaf litter and soil humus, the moisture retention capability of soil is reduced. They further stated that when a cardamom field is abandoned, the early successional stages of the forest are inhibited, with a long-term effect on the regeneration process. The area under cardamom plantation, therefore, should be minimized, or the practice should be abandoned.

Management in the dry eastern region: Although there are a few perennial water sources available in the form of rivers such as Kurumalaiar, Vandiar, Kottaiar, Chinnar and Tirumurthy and Amaravathi reservoirs, most of

the areas in the northeast and southeast of the Sanctuary are dry. The terrestrial mammals, during the dry months, are restricted to areas where water is available. Elephants move to the wet regions in the west during the dry season. However, the other small mammals probably do not have such seasonal migrations. The steep hills in many parts of the east are inaccessible to many mammalian species, especially the larger ones. Therefore, the valleys and streambeds of these hills are critical and must be left undisturbed for local movement of animals. In many places, settlements are placed right inside the most feasible and the only accessible places for animals. For example, the Attukudi settlement has cut off animal movement from Vandiar and Kottaiar towards Kodandur. Isalthittu settlement is another critical point for animals to move between Elumalaikovil and Guddar. Further, the human movement is most frequent between Tirumurthymalai-Kurumalai, Tirumurthymalai-Kottaiar-Attukudi-Kodandur-Chinnar Check Post, Kurumalai-Kulipatti, Poosakottam-Thalamedupatti, Kulipatti-Karumutti, Mavidappu-Upper Aliyar-Navarmalai, Chinnar 9th Checkpost-Elumalaikovil and Vandal-Kadamparai. Although gaur are found in areas grazed by livestock in other sanctuaries such as Mudumalai, in Indira Gandhi Wildlife Sanctuary, the presence of domestic cattle appears to reduce the presence of gaur. Locals informed us that gaur was present in some areas about 50 years back, but is absent now. Although it is not possible to stop the movement of people and livestock immediately, it should be minimized in most crucial areas such as streambeds and valleys. The grazing areas should be clearly demarcated for settlements such as Kurumalai, Kulipatti, Attukudi, and Thalmedupatti. Minimizing grazing may also help to reestablish gaur in many areas where it is now totally absent in spite of habitat suitability. A serious thought must also be given to the eucalyptus plantations raised during 1970s and 1980s in many parts of the eastern ranges. These monoculture plantations could be removed, permitting the native species to regenerate. This would result in an increase in the forage areas for herbivores.

Overall management perspectives: A vision for the Sanctuary 50 years from now must be clearly chalked out. In order to manage these hills scientifically, Nilgiri tahr, elephant and lion-tailed macaque may be taken as flagship species. These species are endangered and represent the terrestrial and arboreal wildlife of these hills.

Tribal settlements should be relocated outside the Sanctuary. However, this is easier said than done. Therefore, a highly pragmatic scheme must be developed with attractive incentives for these people to move out of the forest. It is our observation that most of the younger generation of these tribes are willing to settle outside. This is an intricate social problem and a multi-pronged strategy should be developed with a long-term perspective in mind. For now, the tribes may be supplied with iron poles and raw material for construction of houses. This practice will ease the pressure for logs from the forest.

Periodic monitoring of wild mammals: Due to the limitations of time and other resources, the line transects as well as the plots were monitored only twice in some areas and once in most areas. Data collected in this manner does not provide the statistical rigour that is needed. It is, therefore, suggested that a few transects and plots must be laid out permanently and repeatedly monitored in different seasons. This activity should be differentiated from the annual census. Records on the sightings and movement of larger mammalian species must be regularly maintained by the staff. Weekly entries may be made in the register kept by each range officer. The data may also be computerized to facilitate analysis. Such information would be extremely useful in identification of habitat use patterns by mammals.

Road kills account for a fairly large number of herpetofauna and small mammals (Kumara *et al.* 2000b) in the Sanctuary. Vehicular traffic on the roads inside the Sanctuary must be restricted to the essential at night and in the wet season. There is no need to construct new roads inside the Sanctuary. However, if such a necessity arises, the rainforest areas must be totally avoided. Further, the use of vehicles even by officials should be minimized on three roads: Varagaliyar-Manampalli, Akkamalai-Grasshills and 36HP-Kadamparai Dam. These roads go through the most sensitive areas and should not be open to tourists. Coordination must be established with the managers of tea estates to jointly carry out some conservation activities such as education and to curb the stealing of kills inside the estates.

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APPENDIX-I

TRIBAL SETTLEMENTS WITH APPROXIMATE NUMBER OF HOUSEHOLDS AND LIVESTOCK IN INDIRA GANDHI WILDLIFE SANCTUARY

Sl. No.	Name of settlement	Region	No. of households	Number of cattle
1.	Erumuparai	Wet	40+	Not seen
2.	Kolikamuthi	Wet	40+	Not seen
3.	Varagaliyar	Wet	30+	Not seen
4.	Kumati	Wet	20	Not seen
5.	Nedungundru	Wet	30+	40+
6.	Sankarankudi	Wet	20+	Not seen
7.	Sundaranakudi	Wet	15+	Not seen
8.	Kallarkudi	Wet	14	10+
9.	Cinchonakudi	Wet	15	10+
10.	Udumanparai	Wet	40	15+
11.	Palagankudi	Wet	40+	20+
12.	Kavarakkal	Wet	15+	10+
13.	Kadamparai	Wet	10	Not seen
14.	Vellumudi	Wet	15+	15+
15.	Ithakuli	Wet	10	Not seen
16.	Mavidappu	Dry	35+	200+
17.	Karumutti	Dry	20+	40+
18.	Kulipatti	Dry	30+	50+
19.	Karumalai	Dry	75	250+
20.	Chinnar (Pollachi)	Dry	20+	10+
21.	Jallimuthuparai	Dry	7	10+
22.	Vandal	Dry	50	200+
23.	Kottaiar	Dry	15	20
24.	Atumalaikudi	Dry	15	15+
25.	Kodandur	Dry	15+	300+
26.	Tirumurthy	Dry	20+	100+
27.	Isalthittu	Dry	30+	100+
28.	Poosakottamparai	Dry	10	Not known
29.	Talamedapatti	Dry	10	15+
30.	Selavuthu	Dry	10	25+
31.	Elumalaikovil	Dry	1	10+
32.	Karathupathi	Dry	15	100+
33.	Keelpunachi	Dry	20+	50+
34.	Contour canal	Dry	10+	15+
35.	Navamalai	Dry	15+	50+

APPENDIX-II
TRANSECT NUMBERS, PLACES OF TRANSECT AND DISTANCE OF EACH TRANSECT

Transect No.	Place	Distance (m)	Transect No.	Place	Distance (m)
1	Konalar - towards Vandal	7,000	20	Varagaliyar - Kadavasati	2,000
2	Konalar - Periyakulam	6,000	21	Varagaliyar - Perugundru	2,500
3	Konalar - Kerala border	4,500	22	Varagaliyar - Parambikulam	1,000
4	Waterfall - Iyerpadi	4.000	23	Top Slip - Kolambamalai	2,775
5	Akkamalai - Iyerpadi	5,000	24	Angalakurchi - Erumukundi	3,000
6	36HP - Kavarakal	2,500	25	Navamalai - towards Mavidappu	1,500
7	Waterfall - Upper Aliyar Dam	4,000	26	Contour canal - Shakthi Estate	1,700
8	Mavidappu - Feeder Tank	3,200	27	Tirumurthy Malai - Kurumalai	4,126
9	Attakatti - Andiparai	4.000	28	Kurumalai - Kulipatti	4,576
10	Nedugundru - Power House	4,600	29	Kurumalai - Kottaiar	3,500
11	Nedugundru - Panathiar	3.900	30	Kottaiar - Kodandur	3,000
12	Shekalmudi - Searchtop	4,140	31	Kurumalai - Papamparai	4,780
13	Nallamudi - Edumalaiar	2,500	32	Kurumalai - Guddar	4,226
14	Cinchona Settlement - Itiliar	3,500	33	Guddar - Tirumurthy Malai	4,466
15	Power House - Kumati	3.130	34	Elumalaikovil - Ponganaodai	2,400
16	Top Slip - towards Pandaravarai	3,200	35	Cinnar Chowki - Kodandur	2,500
17	Top Slip - Kathadimalai	2,000	36	Kootar - Thuvanam	4,781
18	Top Slip - Anaigunthi	2,000	37	Amaravathi Dam - Thuvanam	1,750
19	Top Slip - Umayamalai	1,200	38	Amaravathi - towards Kaladigatti	1,500

For locations, see Fig. 2

APPENDIX-III
DISTRIBUTION OF NILGIRI TAHR IN INDIRA GANDHI WILDLIFE SANCTUARY

Hill range	Altitude (m)	Status	Forest Range
Population I			
Panadaravarai (1)	1,200-1,300	8^	Ulandy
Kataradi Malai (2)	"	Present	"
Population II			
Kolambu Malai (3)	500-1,733	6^	Ulandy
Sottakkal Malai (4)	"	Present	"
Kombanpalli Malai (5)	"	5*	Pollachi
Periyasallakatti Malai (6)	"	Present	"
Pachcha Malai (7)	"	Present	"
Varaiyadu Malai (8)	"	5*	"
3 HP (9)	"	9*	"
Navamalai Feeder Tank (10)	"	2*	"
Bhutagundu (11)	"	Present	"
Perunkundru (12)	"	12*	Ulandy
Periyatalanar Malai (13)	"	Present	Valparai
Nadumkundru (14)	"	Present	"
Chinnatalanar Malai (15)	"	Present	"
Population III			
Pamban Malai (16)	1,000-1,150	14^	Ulandy
Vengoli Malai (17)	"	Present	"

APPENDIX-III (*contd.*)
DISTRIBUTION OF NILGIRI TAHR IN INDIRA GANDHI WILDLIFE SANCTUARY

Hill range	Altitude (m)	Status	Forest Range
Population IV			
Palagan Malai (18)	1,014	Present	Manampalli
Population V			
Manjimedu (19)	870-2,212	15^	Pollachi
Thadaganachi Malai (20)	"	5*	Pollachi
Karimedu (21)	"	Present	"
Sanda Malai (22)	"	Present	Udumalpet
Puttu Malai (23)	"	Present	"
Varaiyattutittu (24)	"	Present	"
Keda Malai (25)	"	Present	"
Raman Malai (26)	"	Present	"
Kanji Malai (27)	"	Present	"
Varasatti Malai (28)	"	Present	"
Ten Malai (29)	"	Present	"
Bahirava Malai (30)	"	4*	"
Kokkana Malai (31)	"	Present	Valparai
Pichchi Malai (32)	"	5*	Udumalpet
Attu Malai (33)	"	Present	"
Pambu Malai (34)	"	3*	"
Arasiamma Malai (35)	"	Present	"
Kota Malai (36)	"	Present	"
Rasi Malai (37)	"	Present	"
Population VI			
Pachchapal Malai (38)	1,730	71*	Valparai
Population VII			
Usi Malai (39)	2,150-2,513	Present	Valparai
Tanaka Malai (40)	"	191*	"
Akkamalai (41)	"	6*	"
Tangachi Malai (42)	"	Present	"
Kallar Malai (43)	"	6*	"
Kaludaisutti Malai (44)	"	Present	"
Sedayandi Malai (45)	"	Present	"
Podu Malai (46)	"	8*	"
Population VIII			
Eruma Malai (47)	744	2*	Amaravathi

^Indirect signs; * Seen; Present: - Information from local people
Number in parentheses indicates location in Fig. 4

■ ■ ■

DERMAPTERA IN THE COLLECTION OF THE BOMBAY NATURAL HISTORY SOCIETY, MUMBAI[1]

N. Chaturvedi[2] and G.K. Srivastava[3]

Key words: Dermaptera, Abor Expedition, Assam, Arunachal Pradesh

The study is based upon a part of the collection made during the Abor Expedition — 1911-1912 covering the present day Assam and Arunachal Pradesh. Altogether, 23 species (excluding seven identified up to generic level, since represented either by females or nymphs) belonging to 20 genera are dealt with.

The Dermaptera collection at the Bombay Natural History Society contains 23 species (excluding 7 identified up to generic level only), belonging to 20 genera under 7 families. It is not possible to identify isolated females and nymphs, since the taxonomy of the Order is based primarily on males. A part of the collection (ex Indian Museum) made during the Abor Expedition, 1911-12, conducted in present day Assam and Arunachal Pradesh, was determined and reported by Burr (1913).

Family: Pygidicranidae
Subfamily: Pygidicraninae
Genus: *Cranopygia* Burr, 1908
(= *Kalocrania* Zacher, 1910)

1. *Cranopygia* sp.

1 nymph: Label I (printed) Indian Mus., Rotung, 1400 ft (426.72 m), Abor Exped., 31.xii.1911, M. de Courcy, Label II (handwritten) *Kalocrania siamensis* Dohrn, Label III B-printed, denotes M. Burr; 1 nymph: Label I (printed) Indian Mus., Abor Exped., above Panaji, 400 ft (121.92 m) 16.i.1912, Kemp, Label II (handwritten by Burr) *Kalocrania siamensis* Dohrn; 1 nymph: Label I (printed) Indian Mus., Kobo 400 ft (121.92 m), Abor Exped., 11.xii.1912, Kemp, Label II (handwritten by Burr) *Kalocrania siamensis* Dohrn, Label III B-printed, denotes M. Burr and Label IV (printed) 2349/19 (Regn. No. of Indian Mus., Now Zoological Survey of India [ZSI]).

Remarks: Burr (1913) referred these specimens tentatively to *Kalocrania siamensis* Dohrn, and Hincks (1959) considered it a dubious record. Since only nymphs are present, these could be identified up to the generic level only.

Subfamily: Diplatyinae
Genus: *Diplatys* Serville, 1831

2. *Diplatys* sp.

3 Females: No data on locality.

Remarks: In the absence of a male, it is not possible to identify the species.

3. *Diplatys* sp. 1

1 ex: Label I (printed) Bombay, July 1911, N.B. Kinnear, Label II (handwritten) *Diplatys fletcheri* Burr; 1 ex: Label I Belgaum, N.B. Kinnear, September 7, 1915, Label II (handwritten) *Diplatys fletcheri* Burr.

Remarks: The hind parts in both the specimens are absent. Hence, it is not possible to confirm the species or sex.

4. *Diplatys* sp. 2

1 ex (hind parts broken off): Label I (partly printed and handwritten) Under stones, Chikalda, N.B. Kinnear, 26.xi.1913, Label II (handwritten) *K. kinneri;* 1 Female Label I (partly printed and handwritten) Bombay, N.B.

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Kinnear, July, 1912, Label II (handwritten) *D. kinneri*.

Remarks: An anonymous handwritten det. label *D. kinneri* is attached to both the specimens. It is a manuscript name.

Subfamily: ECHINOSOMATINAE
Genus: *Echinosoma* Serville, 1839

5. ***Echinosoma* sp.**

1 nymph: Label I (printed) Indian Mus., Abor Exped., Sadiya, N.E. Assam, 26.xi.1911, Kemp; Label II (handwritten by Burr) *Echinosoma sumatranum* Haan; 1 nymph: Label I (printed) Indian Mus., Panaji, 400 ft (121.92 m), Abor Exped., 16.i.1912, Kemp; Label II (handwritten by Burr) *Echinosoma sumatranum* Haan.

Remarks: The species could not be confirmed in the absence of a male. Perhaps these are referable to *E. convolutum* Hincks, 1959, which commonly occurs in NE India.

Family: ANISOLABIDIDAE
Subfamily: ANISOLABIDINAE
Genus: *Euborellia* Burr, 1910

6. ***Euborellia femoralis* (Dohrn, 1863)**

1 Female, Dangs, 31.x.1963, E.M. Shull, det. as *Labidura dohrni* (E); 1 Male, Dangs, 31.x.1963, E.M. Shull, det. as *Psalis dohrni* (G).

Remarks: Elytra and wings are well developed in both the specimens.

7. ***Euborellia* sp.**

1 early nymph, Bombay, 17.vii.1975.

8. ***Euborellia annulata* (Fabricius, 1793)**

1 Female: Label I (partly printed and handwritten) Bombay, N.B. Kinnear, July-September, 1912, Label II (handwritten) *Euborellia stali* (Dohrn).

Remarks: The above species name was considered valid by Brindle (1981) and Srivastava (1999).

Genus: *Aborolabis* Srivastava, 1969

9. ***Aborolabis pervicina* (Burr, 1913)**

1 male: Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), Kemp, 28.xii.1911, Label II (printed) Under bark, Label III (handwritten) *Anisolabis pervicina* Burr, Label IV B - printed, denotes M. Burr; 1 Female: Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), Kemp, 29.xii.1911, M. de Courcy Label II (handwritten) *Anisolabis pervicina* Burr, Label III B - printed, denotes M. Burr; 1 Female: Label I (printed) Indian Mus., Abor Exped., Dibrugarh, NE Assam, 17-19.xi.1911, Kemp, Label II (handwritten) *Anisolabis pervicina* Burr.

Genus: *Anisolabella* Zacher, 1911

10. ***Anisolabella dohrni* (Kirby, 1891)**

2 Females: Chikalda Berars, 3644 ft (1110.69 m), 17.xi.1913, N.B. Kinnear, under stones; 1 Female: Chikalda Berars, 3644 ft (1110.69 m), 25.xi.1913, N.B. Kinnear; 3 Females: Bombay, 31.xii.1913, N.B. Kinnear; 1 ex (hind parts missing): Bombay, July 1911, N.B. Kinnear; 1 Female: Bombay, October 1911, N.B. Kinnear.

Genus: *Apolabis* Burr, 1915

11. ***Apolabis aborensis*** (Burr, 1913)

1 Female: Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 25.xii.1911 Kemp, Label II (handwritten by Burr) *Euborellia aborensis* Burr.

Remarks: This specimen may be treated as a paratype, although it was not designated so.

Family: Labiduridae
Subfamily: Nalinae
Genus: *Nala* Zacher, 1910

12. ***Nala lividipes* (Dufour, 1820)**

1 male: Santacruz, Bombay, 7.xi.1912, N.B. Kinnear; 1 Female: Santacruz, Bombay, 6.xi.1912, N.B. Kinnear; 1 ex (hind parts missing): Dangs, 7.xi.1963, E.M. Shull; 1 male: Dangs, 7.xi.1963, E.M. Shull; 1 male: Nalsarovar, Ahmedabad, 17.i.1962, H. Abdulali; 1 Female: Soccoro, Goa, September, 1915, P.F. Gomes.

13. ***Nala nepalensis* (Burr, 1907)**

1 male: Label I (printed) Indian Mus., Abor Exped., Yambung, 1400 ft (426.72 m), 13.i.1912, Kemp, Label II (printed) 2431/19, Label III (handwritten by Burr) *Nala nepalensis* Burr.

Subfamily: Labidurinae
Genus: *Labidura* Leach, 1915

14. ***Labidura riparia* (Pallas, 1773)**
(= *Labidura bengalensis* Dohrn, 1863)

1 Male, 1 Female, 1 ex (hind parts missing): Soccoro, Goa, September 1915, P.F. Gomes; 1 Female: Dangs, 1.x.1963, E.M. Shull; 1 Male: Dangs, 29.ix.1963, E.M. Shull; 1 Female: Dangs, 28.ix.1963, E.M. Shull; 1 ex (hind parts missing): Dangs, 30.x.1963, E.M. Shull; 1 Male: Dangs, 3.x.1963, E.M. Shull; 1 Male: Monghyr, 21.xi.1962, R.B. Grubh; 1 Male: Great Rann of Kutch, March, 1960, P.W. Soman.

Genus: *Forcipula* Bolivar, 1897

15. ***Forcipula* sp.**

1 nymph: Nalsarovar, Ahmedabad, H. Abdulali, 17.ii.1962; earlier determined as nymph of *F. pugnax*; 1 nymph: Belgaum, N.B. Kinnear, 5.ix.1910

16. ***Forcipula abbreviata* Srivastava, 1986**

1 Male: Label I (printed) Indian Mus., Yambung stream, 1100 ft (335.28 m), Abor Exped., 17.i.1912, Kemp, Label II (printed) under stone, Label III (handwritten by Burr) *Forcipula pugnax* Kirby, Label IV (printed) 2419/19 (Regn. No. of Indian Mus., now ZSI); 1 nymph: Label I (printed) Indian Mus., Abor Exped., Yambung stream, 1100 ft (335.28 m), 17.i.1912, Kemp, Label II (printed) under stone, Label III (handwritten by Burr) *Forcipula pugnax* Kirby, Label IV (printed) 2423/19 (Regn. No. of Indian Mus. now ZSI), Label V B - printed, denotes M. Burr.

17. ***Forcipula quadrispinosa* (Dohrn, 1863)**

1 ex: Dangs, 18.ix.1963, E.M. Shull; 2 exs: Dangs, 22.ix.1963, E.M. Shull; 2 Males: Dangs, 2.x.1963, E.M. Shull; 2 exs: Dangs, 6.xi.1963, E.M. Shull; 1 Male: Nasik, 30.xi.1913, N.B. Kinnear; 1 ex: Pune, December, 1924, V.S. La Personne; 1 Female: Soccoro, September, 1915, P.F. Gomes.

Family: Apachydiae
Genus: *Apachyus* Serville, 1831

18. ***Apachyus feae* Bormans, 1894**

1 nymph: Label I (printed) Indian Mus., Kemp, Abor Exped., Yambung, 1100 ft (335.28 m), 14.i.1912, Label II (printed) under bark, Label III (handwritten by Burr) *Apachyus feae*

Borm., Label IV B - printed, denotes M. Burr; 1 nymph: Label I Indian Mus., Abor Exped., Kemp, Rotung, 1400 ft (426.72 m), 28.xii.1911, Label II (printed) under bark, Label III (handwritten by Burr) *Apachyus feae* Borm., Label IV B - printed, denotes M. Burr; 1 nymph: Label I (printed) Indian Mus., Abor Exped, Kemp, Rotung, 1400 ft (426.72 m), 28.xii.1911, Label II (printed) under bark, Label III (handwritten by Burr) *Apachyus feae* Borm., Label IV B - printed, denotes M. Burr; 1 nymph: (only thorax remaining) Label I (printed) Indian Mus., Abor Exped, Dibrugarh, NE Assam, 17-19.xii.1911, Label II (printed) under bark, Label III (handwritten by Burr) *Apachyus feae* Borm., Label IV B - printed, denotes Burr, Label V (printed) 2447/19 (Regn. No. of Indian Mus., now ZSI).

Family: Spongiphoridae
Subfamily: Irdexinae
Genus: *Irdex* Burr, 1911

19. *Irdex nitidipennis* (Bormans, 1894)

(= *Spongophora lutea* Bormans, 1894)
(= *Spongophora aborum* Burr, 1913)
(= *Spongovostox wuermalii* Brindle, 1975)

1 ex (only thorax present): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 25.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Spongovostox luteus* Borm., Label IV B printed, denotes M. Burr; 1 Female (only hind parts): Label I (printed) Indian Mus., Abor Exped. Kobo, 400 ft (121.92 m) 28.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Spongovostox aborum* Burr (Brachypterous E), Label IV (printed) 2268/19 (Regn No. of Indian Mus., now ZSI); 1 Male (hind parts present): Label I (printed) Indian Mus., Abor Exped., Rotung, 23.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Spongovostox aborum* Burr (Brachypterous G), Label IV B - printed, denotes M. Burr; 1 male (anterior portion present): Label I (printed) Indian Mus., Abor Exped., Rotung, 1.xii.1911, Kemp, Label II (printed) under bark, Label III *Spongovostox aborum* Burr (Brachypterous G), Label IV B printed, denotes M. Burr; 1 ex (only head and thorax present): Label I (printed) Indian Mus., Abor Exped., Kobo, 400 ft (121.92 m), 8.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Spongovostox luteus* Borm., Label IV B - printed, denotes M. Burr.

Subfamily: Labiinae
Genus: *Chaetospania* Karsch, 1886

20. *Chaetospania feae* Bormans, 1894

1 Male: Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 28.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Chaetospania feae* Borm. G, Label IV (printed) 2136/19 (Regn. No. of Indian Mus., now ZSI); 1 Female (head missing): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 23.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Chaetospania feae* Borm. E, Label IV 2311/19 (Regn. No. of Indian Mus., now ZSI).

Genus: *Circolabia* Steinmann, 1987

21. *Circolabia curvicauda* (Motschulsky, 1863)

1 Female: Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72m), 23.xii.1911, Label II (printed) rotten wood, Label III (handwritten by Burr) *Labia curvicauda* Motsch.; 1 ex (anterior part remaining): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 29.i.1912,

Label II (printed) rotten wood, Label III (handwritten by Burr) *Labia curvicauda* Motsch.; 1 ex (anterior part remaining): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 23.xii.1911, Label II (printed) rotten wood, Label III (handwritten by Burr) *Labia curvicauda* Motsch.

Family: CHELISOCHIDAE
Subfamily: CHELISOCHINAE
Genus: *Chelisoches* Scudder, 1876

22. ***Chelisoches brevipennis*** **Borelli, 1923**

1 male (anterior parts only): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 24.xii.1911, Label II (printed) under leaf stem of decomposing plantain, Label III (handwritten by Burr) *Chelisoches morio* Fabr., G, Label IV 2389/19 (Regn. No. of Indian Mus., now ZSI);

Genus: *Adiathetus* Burr, 1907

23. ***Adiathetus glaucopterus*** (Bormans, 1894)

1 Male: Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 28.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Adiathetus glaucopterus* Borm., Label IV 2182/19 (Regn. No. of Indian Mus., now ZSI); 2 Males (in one ex. anterior half remaining): Label I (printed) Indian Mus., Abor Exped., Dosing, 1400 ft (426.72 m), 29.i.1912, Kemp; Label II (printed) under bark, Label III (handwritten by Burr) *Adiathetus glaucopterus* Borm. Label IV 2269/19 and 2270/19 (Regn. No. of Indian Mus., now ZSI); 1 ex (damaged): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 28.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Adiathetus glaucopterus* Borm., Label IV 2220/19 (Regn. No. of Indian Mus., now ZSI).

Genus: *Laprophorella* Mjöberg, 1924

24. ***Laprophorella kervillei*** **(Burr, 1905)**

1 Male (hind parts remaining): Label I (printed) Indian Mus., Abor Exped., Dibrugarh, N.E. Assam, 22.ix.1911, Kemp, Label II (partly printed) under leaf sheath of bamboo, Label III (handwritten by Burr) *Lamprophorella kervillei* Burr ♂, Label IV B printed, denotes M. Burr; Label V (printed) 2443/19 (Regn. No. of Indian Mus., now ZSI; 1 Female (anterior portion remaining): Label I (printed) Indian Mus., Abor Exped., Dibrugarh, N.E. Assam, 22.ix.1911; Label II (printed) under leaf sheath of Bamboo, Label III (handwritten by Burr) *Lamprophorella kervillei* Burr, E.

Genus *Hamaxas* Burr, 1907

25. ***Hamaxas kempi*** **Burr, 1913**

1 Female (hind parts missing): Label I (printed) Indian Mus., Abor Exped., Upper Rotung, 4.i.1912, Kemp, Label II (printed) under leaf sheath of plantain, Label III (handwritten by Burr) *Hamaxas kempi* Burr E; 1 Male (hind parts missing): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 29.xii.1911, Kemp, Label II (printed) under leaf sheath of plantain, Label III (handwritten by Burr) *Hamaxas kempi* Burr, G, Label IV 2408/19 (Regn. No. of Indian Mus., now ZSI); 1 Female (hind parts missing): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 28.xii.1911, Kemp, Label II (printed) under leaf sheath of plantain, Label III (handwritten by Burr) *Hamaxas kempi* Burr, E, Label IV 2203/19 (Regn. No. of Indian Mus., now ZSI).

Family: FORFICULIDAE
Subfamily: OPISTHOCOSMIINAE
Genus: *Eparchus* Burr, 1907

26. ***Eparchus insignis*** **(Haan, 1842)**

1 ex (only thorax with wings and elytra

present): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 21.xii.1911, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Eparchus insignis* Haan, Label IV 2172/19 (Regn. No. of Indian Mus., now ZSI).

Genus: *Timomenus* Burr, 1907

27. ***Timomenus lugens*** **(Bormans, 1894)**

1 Male: No data on locality. Det. as *Timomenus nevilli* (Burr).

Subfamily: Allodahlinae

Genus: *Allodahlia* Verhoeff, 1902

28. ***Allodahlia scabriuscula*** **(Serville, 1839)**

1 Female: Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 23.xii.1911, Label II (printed) under bark, Label III (handwritten by Burr) *Allodahlia scabriuscula* Serville, E, Label IV 2160/19 (Regn. No. of Indian Mus., now ZSI); 1 Male (anterior portion present): Label I (printed) Indian Mus., Abor Exped., Rotung, 1400 ft (426.72 m), 28.xii.1911, Label II (printed) under bark, Label III *Allodahlia scabriuscula* Serville, G, Label IV 2146/19 (Regn. No. of Indian Mus., now ZSI); 1 Male: Label I (printed) Indian Mus., Abor Exped., Below Dosing, 1400 ft (426.72 m), 29.i.1912; Label II (printed) under bark, Label III *Allodahlia scabriuscula* Serville, G; 1 Male (hind portion present): Label I (printed) Indian Mus., Abor Exped., Kobo, 400 ft (121.92 m), 1.xii.1911, Kemp, Label II (printed) under bark, Label III *Allodahlia scabriuscula* Serville, G.

Subfamily: Forficulinae

Genus: *Elaunon* Burr, 1907

29. ***Elaunon bipartitus*** (Kirby, 1891)

1 Female (head missing): Label I (printed) Indian Mus., Abor Exped., above Panaji, 4000 ft (1219.2 m), 16.i.1912, Kemp, Label II (printed) under bark, Label III (handwritten by Burr) *Elaunon bipartitus* Kirby, Label IV B printed, denotes M. Burr, Label V 2326/19 (Regn. No. of Indian Mus., now ZSI); 1 ex (elytra and wings only present): Label I (printed) Indian Mus., Abor Exped., above Panaji, 4000 ft (1219.2 m), 16.i.1912, Kemp, Label II (printed) under bark; Label III (handwritten by Burr) *Elaunon bipartitus* Kirby, Label IV B - printed, denotes M. Burr, Label V) 2320/19 (Regn. No. of Indian Mus., now ZSI).

Subfamily: Diaperasticinae

Genus: *Diaperasticus* Burr, 1907

30. ***Diaperasticus erythrocephalus*** (Olivier, 1891)

1 Female (hind parts missing): Label I (printed) Belgaum, N.B. Kinnear, 4 September, 1910, Label II (handwritten) *Elaunon erythrocephalus*, E, W. Kirby.

Remarks: This species is distributed in Africa and Madgascar only. The above identification is dubious. The hind parts of the specimen are missing.

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CHARACTERIZATION OF THE GENETIC STATUS OF POPULATIONS OF RED JUNGLEFOWL[1]

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(*With one text-figure*)

Key words: Red junglefowl, *Gallus gallus*, chicken, domestication, genome conservation, hybridization

The native range of the red junglefowl (*Gallus gallus*) in Southeast Asia and the Indian subcontinent has been the focus of studies of domestication of this species that became the foundation of a worldwide multi-billion dollar poultry industry. Such studies must be based on a thorough understanding of the behaviour, ecology, and biogeography of current as well as past populations. Although red junglefowl are considered abundant both in captivity and in the wild, and have usually not been accorded any particular conservation concern, almost all populations show morphological characteristics suggestive of past hybridization with domestic birds, and indeed pure genomes may prove to be now extinct in the wild. However, one captive population still shows two morphological characteristics considered to be indicative of genetic purity: (1) an annual moult to a dark/black eclipse plumage in the male, and (2) complete absence of combs in females. Preliminary molecular genetic studies of these birds indicate that they are more distinct from other captive strains than the latter are from domestic chickens. These captive birds may thus represent the last pure red junglefowl genomes. This paper establishes criteria for the judgment of genetic purity, in the hope that colleagues across southern Asia will assess local wild populations to develop an accurate picture of the genetic status of this species across its range.

INTRODUCTION

Red junglefowl (*Gallus gallus*) represent the ancestor of the most important bird species in economic terms — chickens, which constitute the basis for the multi-billion dollar poultry industry. Although wild red junglefowl are generally not considered to be of any conservation concern, studies of historical and recent museum specimens suggest that wild genomes may be critically endangered or even extinct in the natural state (Peterson and Brisbin 1998). One captive population (hereafter referred to as the JFW strain), however, has been kept in genetic isolation for more than three decades (Brisbin 2000, Hawkins 2001), and shows morphological characteristics which may offer unique insights into the history and current status of the red junglefowl.

To approach these questions of genetic purity, however, requires a thorough knowledge of the morphological, ecological, and genetic characteristics of both the present-day and historical junglefowl populations. Traditionally, such studies have been based on examination of the phenotype, particularly as manifested in studies of captive birds and museum specimens (Delacour 1977). More recently, quantitative studies of museum specimens have revealed patterns of successive loss of characters presumed to indicate genetic purity in wild populations

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(Peterson and Brisbin 1998). The picture, nevertheless, remains incomplete, with only fragmentary survey information for wild populations and captive strains, as well as poor understanding of phenotypic markers used for such surveys (Peterson and Brisbin 1998). Additional tools drawn from molecular genetics and zooarchaeology have yet to be applied to this question; the purpose of this paper is to initiate the collection of such information, as well as to stimulate broader surveys of wild populations and captive strains.

Morphological Characteristics of Pure Wild Red Junglefowl

Our evaluation of the morphological characteristics of pure red junglefowl is based on features considered characteristic of genetically pure wild red junglefowl (Delacour 1977). Critical characters include (1) a complete moult to an overall dark/black "eclipse" plumage by the male following the breeding season (generally June-September), and (2) complete absence of a comb in the adult female. Other traits are cited as distinguishing pure wild junglefowl (Nyunt 1993) but have been generally found to be less reliable: (1) slender, dusky tarsi of wild birds are shared by several domestic forms (Smyth 1990), (2) longer spur-lengths than domestics (Nyunt 1993) has been discounted by our preliminary studies (Brisbin and Peterson unpubl. data).

We have surveyed informally the occurrence of male eclipse plumages in captive red junglefowl in North America, as well as in 351 skins of adult wild junglefowl in 19 museum collections (Peterson and Brisbin 1998). These surveys suggest that the JFW population is the only North American red junglefowl captive population in which all birds consistently show the two characters listed above. The museum surveys also indicated, on the basis of the occurrence of male eclipse plumages, that genetically pure red junglefowl may also be extinct or critically endangered in the wild. This trait apparently disappeared from extreme Southeast Asia and the Philippines (if the latter populations are indeed native) prior to the mid-late 1800s, and from the Malaysian region in the 1920s. Two recently examined skins indicate the survival of eclipse plumages on Hainan Island until the 1930s (Beijing Zoological Institute 01587, 01586). The last museum specimens showing male eclipse plumages were taken from north-central India in the mid to late 1960s (Peterson and Brisbin 1998), exactly the time and place that the founders of the JFW population were brought out of the wild as part of an exotic gamebird propagation and release program of the U.S. Fish and Wildlife Service (Bohl and Bump 1970).

History of the JFW Red Junglefowl Population

The morphology and geographic distribution of extant subspecies of red junglefowl have been described and analysed in detail for decades (Delacour 1977). Studies of the JFW population, however, have raised serious questions concerning the morphological and genetic characteristics of pure red junglefowl (Peterson and Brisbin 1998). This small captive population is now being maintained by a consortium of private aviculturists in the southeastern United States (Brisbin 1996, Brisbin 2000, Hawkins 2001), and may now represent the only source of genetically pure red junglefowl in the wild or in captivity (Peterson and Brisbin 1998).

The JFW population was established from a small but undocumented number of founders captured in north-central India, in the vicinity of Dehra Dun, in the mid to late 1960s (Bohl and Bump 1970). Descendents of the wild founders were distributed to propagation centres in eight states in the southeastern United States, where over 6,000 birds were produced and released in natural habitats throughout the

region. Over the years, however, there has been no indication of long-term survival of free-ranging birds in any of the releases, and the program was terminated in the late 1960s.

At this time, a second founder population of 50 chicks was taken from the Bowen's Mill hatchery, near Fitzgerald, Georgia, USA, and moved to the University of Georgia's Savannah River Ecology Laboratory, near Aiken, South Carolina. They were maintained in captivity and used in behavioural and ecological studies for several years (Brisbin 1969). From the early to mid 1970s through 1997, the entire JFW population was maintained in random pure captive propagation by a private aviculturist in Tuscaloosa, Alabama, with an annual pre-breeding population size of 10-20 adults of approximately equal sex ratio. Morphological and behavioural characteristics did not change appreciably from those of the original birds nearly 30 years earlier.

This character stability has been particularly true regarding the extremely wary and flighty nature of the JFW birds, which has persisted in spite of continuing efforts to imprint and tame incubator-raised chicks. These observations confirm the findings of earlier behavioural studies that indicated little modification of their flighty nature in foster-rearing under tamed hybrid "zoo-type" red junglefowl hens (Brisbin 1969). Foster-reared birds, upon attaining sexual maturity, showed little tendency to integrate into the social hierarchy of the resident, free-ranging flock of hybrid junglefowl. They kept to themselves, and eventually dispersed into neighbouring wooded habitats and disappeared.

In 1998, 65 hatch-year JFW birds were removed from the collection in Alabama and distributed among several private aviculturists in Georgia and South Carolina with a dozen or so adult breeders being retained in the Alabama collection. The population is thus dispersed now among experienced breeders, who are working together to ensure the continued existence of documented genetically pure birds in several captive sub-populations.

Molecular Genetic Studies

The unique nature of the JFW population suggested the importance of a molecular genetic characterization of these birds, particularly in the light of recent efforts to use molecular methods to identify the wild ancestors of domestic chickens (Siegel *et al.* 1992, Fumihito *et al.* 1994, 1996). Though preliminary, the results of our first steps in this direction are reported below.

Mitochondrial gene sequences were derived from PCR amplification products obtained from feather samples. Samples were taken from two JFW individuals, a domestic chicken of undetermined breed, and two domestic/feral bantam chickens from a specially-bred flock at the Savannah River Ecology Laboratory (Brisbin 1993). Samples were also analyzed from two captive zoo junglefowl with morphological characteristics suggestive of domestic contamination, from the Riverbanks Zoo, Columbia, South Carolina; these birds were direct descendants of the free-ranging "red junglefowl" formerly maintained at the San Diego Zoo (Collias *et al.* 1994). Outgroups for phylogenetic analyses included similar samples from a green junglefowl (*Gallus varius*), Malayan peacock-pheasant (*Polyplectron malacense*), and Bornean peacock-pheasant (*P. schleiermacheri*), all from the collections of the New York Zoological Society.

We sequenced 1011 base pairs from two regions of the mitochondrial DNA (mtDNA) genome: (1) the relatively conservative 16S ribosomal gene, and (2) a portion of the more variable, protein-coding, cytochrome *b* gene. We used published primers based on the domestic chicken sequence for PCR amplification, and PCR products were sequenced directly on an ABI automated sequencer.

The 16S sequence data were invariant in

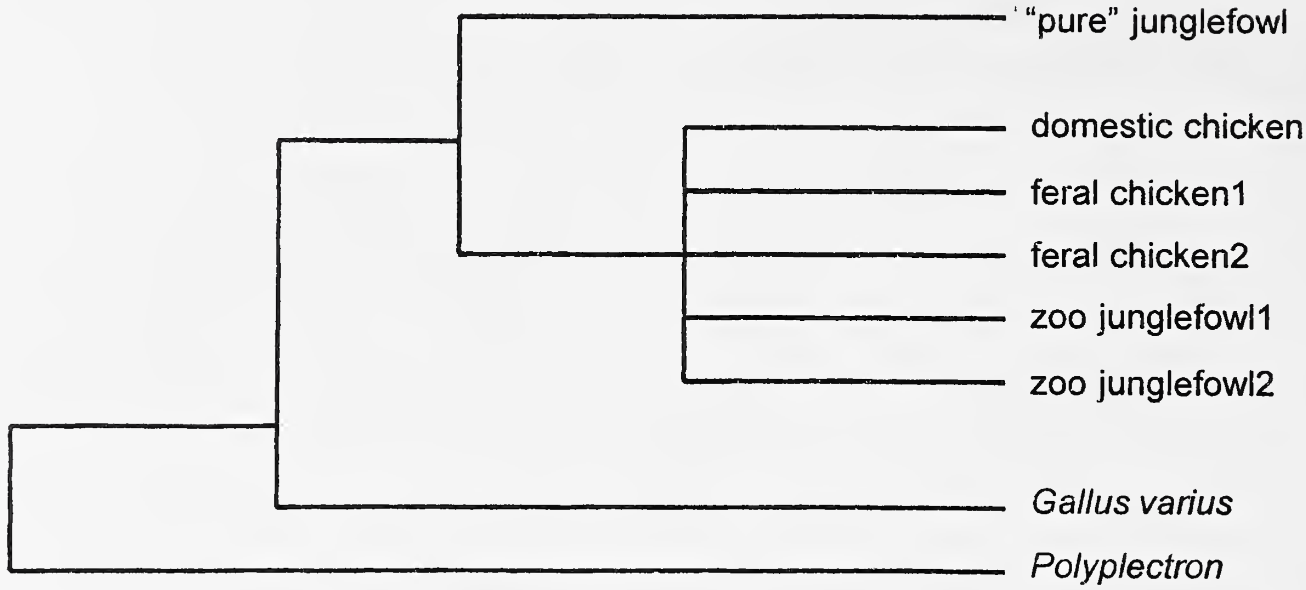

Fig. 1. Diagrammatic representation of results of preliminary phylogenetic analyses of mitochondrial DNA sequence data in junglefowl, chickens, and related pheasants. Feral chickens were taken from a special flock developed at the Savannah River Ecology Laboratory; individuals 1 and 2 represent different specimens of each form

all four junglefowl and the domestic chicken. Sequences of the green junglefowl and the two peacock-pheasants were distinct. This result is more or less typical for this highly conserved gene region. Cytochrome *b* sequences, considering the small number of red junglefowl sampled, were fairly variable. The same sites were variable in both the JFW and zoo junglefowl groups. The two JFW individuals had identical haplotypes, which was not surprising, considering the bottlenecks of low population numbers in the history of this group.

We analyzed these data phylogenetically, treating individual bases as unweighted and unordered characters. A single, most parsimonious tree placed the JFW birds basal to the two zoo junglefowl and domestic chicken (Fig. 1; consistency index 0.86). Genetic distances between the zoo junglefowl and domestic chickens were shorter than between the zoo junglefowl and the JFW birds. Most importantly, the JFW haplotype included two sites that were plesiomorphic when polarized by outgroup comparison, suggesting that this population does not share the common ancestry that is shared by the domestic chickens and the zoo junglefowl. Still, caution must be used in interpreting this information, given the small sample sizes available.

We sequenced additional mtDNA from a single JFW male to parallel prior studies of chicken and junglefowl molecular genetics, focusing on the 392 base pair portion of the noncoding control region studied by previous investigators (Fumihito *et al.* 1994, 1996). The work of these authors, however, lacked samples from the western extreme of the species' distribution in India. Our resulting JFW sequence showed 2% divergence from the published Barred Rock domestic chicken sequence (Fumihito *et al.* 1996). The JFW sequence fell within a clade that included all domestic sequences, and grouped broadly with Thai red junglefowl and Asian domestics, but was more distinct from western domestics. If the JFW sample had fallen outside of the domestic clade, the Thai-origin model (Fumihito *et al.* 1994, 1996) would have been supported. Rather, our results failed to support the conclusion of a Southeast Asian origin of domestic chickens.

Our molecular data do not exclude a model of Indian origin of domestic chickens. Here, the DNA composition of the Southeast Asian junglefowl used in previous studies (Fumihito *et*

al. 1994, 1996) would be interpreted as showing the effects of hybridization with feral or domestic village chickens in that portion of the species' distribution. Under this scenario, Fumihito *et al.'s* Indonesian genotypes could possibly represent the original Asian red junglefowl types. To support this alternative model, it would be necessary to show that museum specimens of birds collected earlier in Southeast Asia have different mtDNA types from those "red junglefowl" now found there, and that Indian red junglefowl have high mtDNA diversity.

Taken together, the above findings have important implications for understanding chicken domestication. They particularly emphasize the importance of documenting the characteristics and history of populations from which samples are taken for DNA analysis. In the case of Fumihito *et al.* (1994, 1996), "wild" Southeast Asian junglefowl profiles were based on samples taken from zoo birds and other populations of unknown provenance. Personal observations by ILB, however, suggests that the wild behaviour of pure red junglefowl, such as the JFW birds, prevents them from being maintained on exhibition in most public zoo collections, where stress would be extreme. Furthermore, the external morphology of all zoo junglefowl we have observed fails to conform to the characteristics of pure wild genetic ancestry (Delacour 1977). Thus, without further information, the Tama Zoological Garden's "Thai red junglefowl" used in the molecular studies (Fumihito *et al.* 1994, 1996) must remain suspicious as possibly showing the results of past genetic contamination. Additionally, birds described by the same authors as "gifts from the Department of Forestry of the Thai government" could have been obtained from near villages, where hybridization could have occurred even in the free-ranging state. In fact, our studies of museum specimens (Peterson and Brisbin 1998) suggest that morphological traits indicative of pure wild ancestry disappeared from these areas over 60 years before the sampling for that study. Hence, there is a real possibility that the similarity of molecular characters of these birds to those of domestic birds results from past hybridization, rather than being indicative of their status as the progenitor of the domestic birds.

Implications for Chicken Domestication

An important application of our findings is in the interpretation of ancient artifactual depictions of birds. Regarding traits indicative of pure wild stock (Delacour 1977), we are unaware of any representation of a male *Gallus* in what could be the dusky eclipse plumage, lacking the elongated bright-coloured neck hackles. The absence of such representation suggests either that this trait was lost early in the domestication process, or perhaps that its drab appearance was not considered worthy of depiction by ancient people. Similarly, with one possible exception, we are unaware of any representation of early female *Gallus* lacking a visible comb and facial wattles. An early Egyptian "chicken hieroglyph" depicts "the chick . . . but never an adult bird" (Zeuner 1963), which is the only possible exception. Given that the wild junglefowl would be combless in the adult hen (Delacour 1977), we suspect that this hieroglyph may actually depict a combless hen such as those of the JFW strain.

An important question is how could ancient people with limited facilities and skills for husbandry have managed to tame junglefowl to produce a captive and later domestic population, from such a wild and wary bird? Even early imprinted and hand-reared chicks of wild stock would have been extremely difficult if not impossible for ancient people to raise and breed successfully in full captivity or semi-confinement (Brisbin 1969, Bohl and Bump 1970). A more likely ancestor of domestic chickens would be more docile in disposition, show a prominent comb in hens, and might lack an eclipse plumage

in the male. The discovery of such a population would leave unanswered the question of the status of populations of India, including the JFW birds.

Hence, our studies raise the possibility that the JFW population may represent a well-differentiated group within red junglefowl, possibly a cryptic species, that may not have been involved in the domestication of chickens. Such a scenario has important implications both for understanding the biogeography and ecology of chicken domestication, as well as for the conservation of populations of captive and free-ranging red junglefowl. Perhaps the most parsimonious conclusion, however, is still that of the genetic purity of the JFW population, and the contamination of the rest of the populations of this species.

Future Directions

Clearly, continuing the pure captive propagation of the JFW population remains a priority. As available numbers and natural mortality permits, we are preparing a complete age series of study skins and skeletal material from these birds to permit thorough molecular and phenotypic comparisons. Several other research avenues remain, however, including the following:

1. Broad molecular surveys to establish phylogenetic patterns with much-improved detail, presently under development.
2. Broad phenotypic surveys to document geographic pattern of variation in critical characters, particularly as regards detection of previously unappreciated geographic breaks.
3. Limited hybridization and backcross experiments to assess the genetic basis for the phenotypic markers described above. Such experiments have now passed to the second generation of backcross of hybrids to JFW stock, providing a known-purity standard for evaluation of phenotypic markers.
4. Surveys of phenotypic and molecular characteristics of wild and captive populations of red junglefowl. This step is particularly critical in eastern and north-central India, where the probability of survival of pure stock is highest; some indications exist of possibly "clean" captive and wild populations in some remote areas of India (G. Das, pers. comm.), making this step of utmost importance.

ACKNOWLEDGEMENTS

None of these studies would have been possible without Isaac Richardson, who single-handedly maintained the JFW red junglefowl in pure propagation for over 25 years. Efforts to continue propagation of this strain have now been undertaken by the Georgia Game Bird Breeders Association and the Virginia-Carolinas Pheasant and Waterfowl Association, under the leadership of Al Cumming and Wayne Hawkins, respectively. We are grateful to Ed Diebold and Bob Siebels of the Riverbanks Zoo for help in obtaining DNA samples from zoo junglefowl, Don Bruning of the Wildlife Conservation Society for continuing encouragement, and Stan Vesey and John Glisson for veterinary support. The senior author also thanks Alan Poole, Leo Joseph, and the staff of the Academy of Natural Sciences of Philadelphia for hospitality and support while working in their collections; the Zoological Institute of Beijing kindly provided access to specimens for examination by ATP. Studies were supported in part by financial assistance award number DE-FC09-96-SR18546 from the United States Department of Energy to the University of Georgia's Savannah River Ecology Laboratory. This paper is respectfully dedicated to the memory of Gardiner Bump and Wayne H. Bohl, whose tireless efforts in the 1960s and 1970s resulted in saving what may now be the last living remnant of the wild ancestor of the domestic chicken.

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THE GENUS *PONTIA* FABRICIUS (LEPIDOPTERA: PIERIDAE) IN THE KUMAON HIMALAYA[1]

Peter Smetacek[2]

(*With one text-figure*)

Key words: Lepidoptera, Pieridae, *Pontia*, Himalaya, faunal drift

The range of *Pontia daplidice* Linnaeus and *Pontia glauconome* Klug is extended eastward to the Kumaon Himalaya. An uncertain record of *Pontia chloridice* Huebner from the same area is noted. The possibility of this faunal drift being a recent phenomenon is examined.

Taxonomy

In the Indian sub-region, three species are generally assigned to the genus *Pontia* Fabricius. These are *daplidice* Linnaeus, *chloridice* Huebner and *glauconome* Klug. *Pontia* is sometimes treated as a sub-genus or synonym of *Pieris* Schrank (Evans 1932a, Wynter-Blyth 1957). Some authors (Watson and Whalley 1983, Daccordi *et al.* 1988) include *callidice* Huebner in *Pontia*, although Varshney (1993) treats *callidice* as the type species of the genus *Synchloe* Huebner. For the purpose of this paper, I have followed Varshney (op. cit.), since this is the most recent work on the subject.

Geography

The Kumaon Himalaya consists of a section of the Himalayan range, from the low sub-montane tract known as the Bhabar to the trans-Himalayan region, extending between 28° 44' - 30° 49' N and 78° 44'-81° 01' E. Broadly speaking, the area consists of three parallel mountain ranges.

The outermost range rises steeply above the plains to more than 2,000 m above msl, reaching 2,600 m in some peaks near Nainital. Rainfall is heaviest on the southern slopes of this range, between 1,981 cm and 3,048 cm annually. This area receives the major part of its annual precipitation during the southwest monsoon from June to September. Most of the sites mentioned in this paper are situated in this range i.e. Nainital, Bhimtal, Sattal, Naukuchiatal, Ramgarh, Gethia in Kumaon and Mussoorie in Garhwal. Some of the precipitation is in the form of winter snow in Nainital, Ramgarh and Mussoorie, but this is not usual in the other places mentioned.

North of this lies the middle range in which Almora, Panuanaula and Binsar are situated. This range is generally lower than the outer range, although it rises in places to nearly 2,600 m above msl. The middle range receives less precipitation and is altogether drier than the outer range. As in the outer range, there is snowfall above 1,600 m in winter and all the three places mentioned above experience snowfall.

Further north lies the main Himalayan range, which is too well known to warrant description here. It receives most of its precipitation in the form of snow above 4,000 m. Between 1,400 m and 4,000 m, the precipitation is in the form of rain in summer and snow in winter, while below 1,200 m, snow is not usual even in winter.

North of this range lies the trans-Himalayan rain shadow area. Members of the *Pontia* genus have been recorded from the rain shadow area of Ladakh and Himachal Pradesh, but not of Uttaranchal.

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Distribution

Concerning the distribution of the genus *Pontia*, Varshney (1993) noted that it is a Palaearctic subelement, centred in Pakistan and northwest India, extending to Iran, the Middle East and Asia Minor. Within the Indian sub-region, he gave Baluchistan, Chitral and Punjab in Pakistan and Ladakh in Jammu and Kashmir as the area from where these butterflies have been recorded.

Watson and Whalley (1983), however, state that *Pontia* has the most species in Europe and temperate Asia, with a few known from North Africa. They go on to caution about catalogues of the genus where there are many names, the majority of which are sub-species or forms of *daplidice*.

The known range of *P. daplidice* is N. Africa, southern Europe to India and Japan (Lewis 1973). Watson and Whalley (op. cit.) omit N. Africa, but include Britain. Within the Indian sub-region, it has been recorded from Baluchistan to Chitral and Murree in Pakistan (Evans 1932a). Peile (1937) added Peshawar in Pakistan and Wynter-Blyth (1957) added Kashmir to Shipki in the erstwhile state of Bashahr in present day Himachal Pradesh to this range (Fig. 1).

I have found *P. daplidice* to be a common butterfly in Kumaon. It occurs from the outermost range of the foothills to the main Himalayan range. In the foothills, it occurs between 1,200 m and 2,400 m elevation and has been recorded from Sattal (approx. 1,200 m), Bhimtal valley (1,400-1,500 m), Nainital (1,800-2,400 m), Ramgarh (1,800-2,200 m) and Gethia (approx. 1,400 m) in Nainital district and Binsar (2,400 m), Almora (1,600-1,800 m) and between Bhuteshwar and Panuanaula (approx. 1,800 m) in Almora district.

In the main range, I found it in the Dhauli Ganga Valley north of Joshimath in Chamoli district, Garhwal at 1,800 m to 2,200 m and there is a record from Khati village (2,500 m) on the route to the Pindari glacier in Bageshwar district, northern Kumaon.

The present records extend the known range of this species by about 300 km south-southeast from Shipki, which was its previous limit, to Naukuchiatal and Khati. The present eastern limit of this butterfly's range in the area is uncertain, but so far I have no records from Pithoragarh district on the border with Nepal. It should be mentioned that there have been no recent surveys in that district.

The recorded range of *chloridice* is from S. Europe to Iran and Mongolia as well as North America (Watson and Whalley op. cit.). Lewis (op. cit.) added Tibet, southwest China and east Siberia to this range. Within the Indian sub-region, it has been recorded from Baluchistan, Chitral and Ladakh according to Evans (1932a) and Peile (op. cit.). Wynter-Blyth (op. cit.) did not mention this taxon, since its known distribution was outside the area covered by his book.

Hannyngton (1910) recorded this species from Kumaon at an elevation of 3,650 m in August and September, and noted that it was rare. It is not clear why Evans (op. cit.) and Peile (op. cit.) subsequently overlooked this record, even though Peile included Hannyngton's list among the appendices to his book. This matter is discussed further on.

The third member of the genus, *P. glauconome*, is known from east Africa, Arabia, Iran, Baluchistan, Punjab and Chitral in Pakistan, according to Evans (op. cit., 1932b), Peile (op. cit.) and Wynter-Blyth (op. cit.). The latter added Karachi, while Peile added Iraq to this range.

Roonwal *et al.* (1956) reported a specimen of *glauconome* from Mussoorie in Garhwal, in the collection of the Forest Research Institute, Dehra Dun. In addition, I have an extreme dry season form of *glauconome* recorded at Bhimtal on May 1, 1976, with a forewing length of 20 mm. This record extends the known range by

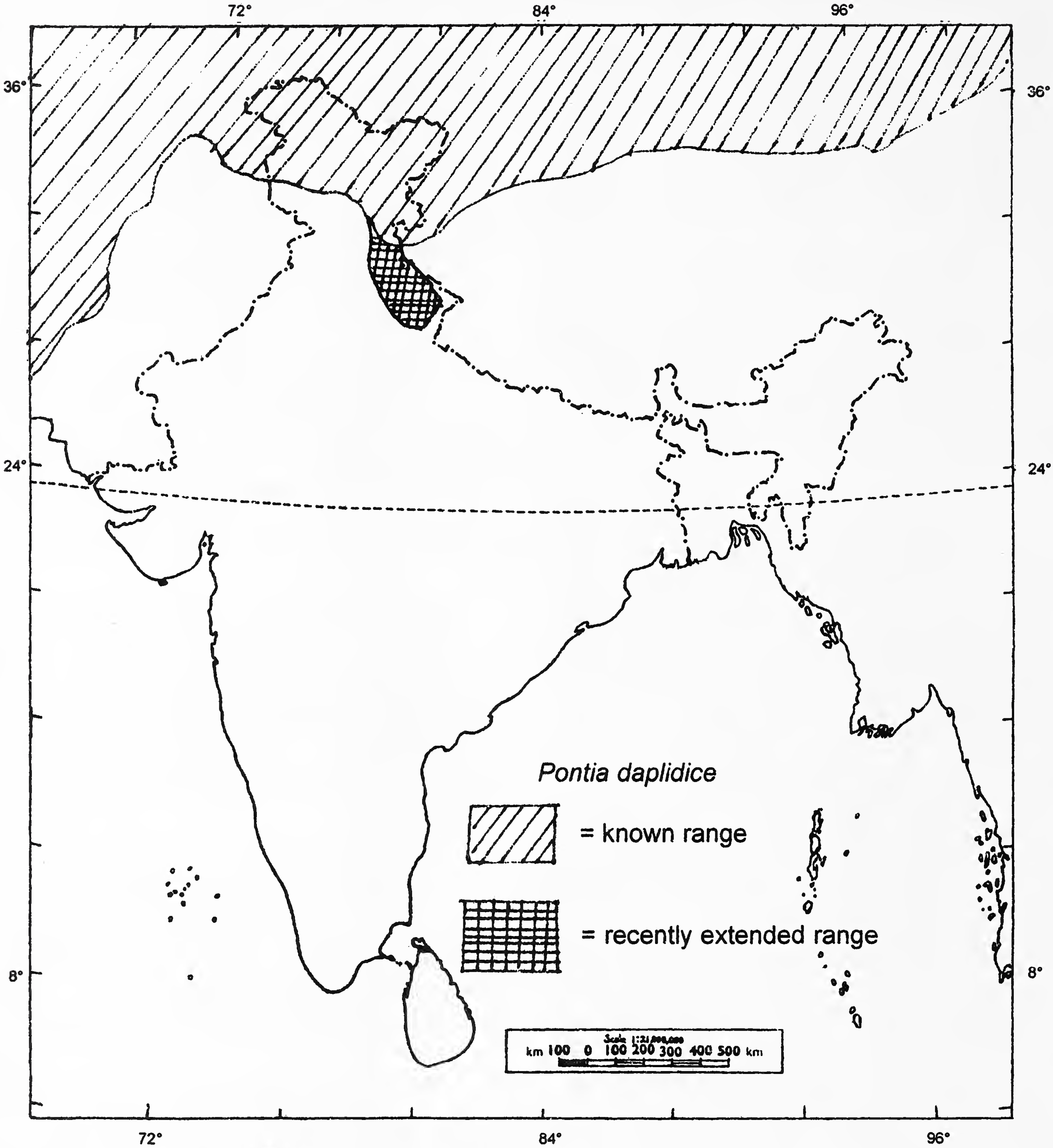

Fig. 1: Map indicating the known and extended range of *Pontia daplidice*

nearly 200 km east-southeast of Mussoorie, its previous eastern limit.

On the basis of the abovementioned records, the range of all three members of the genus from the Indian sub-region is extended to the Kumaon Himalaya. The occurrence of *chloridice* is a little uncertain, since we have only Hannyngton's (1910) report to rely on, but the records for *daplidice* and *glauconome* are backed by specimens.

Habits and Habitat

The following account deals only with *daplidice*. According to Peile (1937), it is on the wing in April, and during September and October near Peshawar and Miriamshah in Pakistan. He found it rare.

In Kumaon, it is multivoltine in the outer ranges, on the wing from March to July and in September and October, with stragglers appearing as late as December. In the main range, it appears to be uni- or bivoltine, since it has been found between May and early August, but not before or after. Given that seasons are better defined in the main range than in the outer ranges, and the cold season more severe, it is unlikely that this insect is as prolific there as it is in the outer ranges. Of interest is the fact that it is on the wing even in July and the first few days of August, at the height of the southwest monsoon, in the outer range.

On the wing, it is often very similar to *Artogeia canidia* Sparrman (Pieridae), which occurs at the same places and times as *daplidice*. Generally, however, the flight is rapid, rather swifter than *canidia* and nearer the ground. It is fond of fields, sunny paths and ridges. I have never found it within shady forests. Rather, it keeps to the open parts and will rise above the level of the trees to cross the shady parts, although it generally keeps low in the open.

Both sexes settle frequently on the low growing flowers of Compositae (*Senecio* Linn., *Erigeron bellidioides* (Buch. Ham., ex D. Don) Benth. ex C.B. Clarke), as well as to bask with wings closed or partially open on low plants or on the ground. I have not met them visiting water or damp mud.

Breeding

This account deals only with *daplidice*. The larvae of the nominate subspecies are known to feed on species of Cruciferae (Friedrich 1983). The subspecies *moorei* Roeber does not appear to have been actually bred in India until now.

Females of *daplidice* were observed ovipositing on immature seeds and leaves of *Lepidium virginicum* Linn. (Cruciferae). The plants with the ova were placed in a breeding box, where the larvae emerged within a week, but did not survive. Subsequently, second instar and third instar larvae were located on plants of the same species, and successfully bred through. One individual pupated on June 3, 1998 and emerged on June 8, 1998. Others pupated for more or less the same period, but it is not possible to give exact dates since they were kept together. The larval stage probably lasts a fortnight or three weeks, giving a time frame of a brood a month or every five weeks during summer in the outer ranges. This means that in the outer ranges, there is a more or less continuous succession of broods during spring and summer.

The host plant, *Lepidium virginicum* (Virginia Peppergrass; Bird's Pepper; Virginia Pepperweed) is a native of North America and is widespread from the Atlantic coast to the Rocky Mountains, West Indies, Mexico, Central and South America. It has been introduced to India, most probably as part of the U.S. grain shipments during the 1950s and 1960s. Maheshwari and Paul (1973) reported its spread to the Netarhat Plateau, Bihar.

Unfortunately, there is no record of when this weed reached Kumaon. Gupta (1968) did not mention it. Gupta (1968) mentioned

Lepidium ruderale Linn., which Maheshwari and Paul (1973) note is often misapplied to *L. virginicum* in Indian herbaria. Since *L. ruderale* is also cultivated, it is unlikely that Gupta (op. cit.) misidentified it.

Today, *L. virginicum* is naturalised in different parts of India and is frequently abundant in degraded areas, roadside swards, vacant lots, fallow fields and neglected lawns. In Kumaon, it germinates in early spring and dies down by September.

Seasonal Variation

Peile (1937) noted that *daplidice* varies much with the season. Individuals recorded in Kumaon display a little seasonal variation, in that the apical dark area on the forewing *recto* is relatively lighter and the individuals large in the spring brood(s), i.e. from March to May. Individuals recorded in June are small and heavily marked on the forewing *recto*, while the post-monsoon brood from September and October is of the same size as the spring brood and heavily marked, the white sub-marginal spots on the forewing *recto* often greatly reduced, with some absent. The green markings on the *verso* surface do not vary much, either individually or seasonally.

The individual of *glauconome* was recorded in May, the height of the dry season. It is a typical dry season form of the species, with the green markings on the *verso* surface almost obsolete, but the veins on the hindwing *verso* prominently yellow.

Discussion

Pontia daplidice is a known migrant, individuals crossing to Britain from the European mainland (Watson and Whalley 1983), from low elevation to high elevation in erstwhile Czechoslovakia (Kudrna 1974a) and from the Asian mainland to Japan (Kudrna 1974b).

Mackinnon and de Nicéville (1897) did not find *daplidice* in Mussoorie or the Dun Valley, and Hannyngton (1910) did not find it in Kumaon although both these lists are very nearly complete. R.C. Busher, who collected butterflies around Nainital and compiled an unpublished list of local butterflies in 1918 (ms in author's possession), including interesting species in the Vanrennen collection, did not include *daplidice*. Nor does it find mention in notes compiled by my father, the late Fred Smetacek Sr., from the Nainital, Bhimtal and Naukuchiatal area during 1949 and 1950.

It first appears in notes compiled in 1961, with what appears to be the first pair recorded from Sattal (1,200 m) near Bhimtal on April 21, 1961, by my father. The notes state "Not rare at Sattal and Nainital in late April and May 1961. Rarer in 1962. Also flies during September and October. Also captured at Bhimtal on August 27, 1964." (Victor Smetacek's notes).

It appears probable that, rather than having been overlooked, this species colonised the outer ranges of Kumaon between 1950 and 1961.

Of interest is the record of *P. daplidice* by Atkinson (1882) from the main Himalayan range between the Tons and Sarda rivers, i.e. the present state of Uttaranchal. He stated that his list is based, with few exceptions, on actual specimens collected by him or others. It is unclear why Hannyngton (op. cit.) and other authors overlooked this record, unless the specimen was subsequently identified as *chloridice*, which is similar.

This would explain the presence of *daplidice* and absence of *chloridice* from Atkinson's list and the presence of *chloridice* and absence of *daplidice* from Hannyngton's list. Whatever the truth of these surmises, they are to do with the main Himalayan range and do not alter the fact that the colonisation of the middle and outermost ranges of the Himalaya in Kumaon by *daplidice* appears to be recent.

Added to this, Atkinson's (1882) list is not impeccable, and among numerous misidentifications may be cited *Rhapicera satricus* Doub. for what was probably *Rhapicera moorei* Butler; *Vanessa urticae* Linn. for *Aglais cashmirensis* Koll. and "*Argynnis*" *rudra* Moore which does not occur west of Meghalaya.

During the winter of 1998-1999, the rains were very meagre. As a result, spring was very dry and many annuals failed to germinate. Among these was *Lepidium virginicum* which appeared only in irrigated valleys, but not at all in the waste ground and roadside swards all over Nainital district.

The population of *Pontia daplidice* tumbled more or less correspondingly after the first brood, so that in late May I saw none and in June only a single freshly emerged female. Normally, in the *c.* 25 km between Bhimtal and Gethia or Nainital, it was possible to see at least a dozen individuals every day during the season.

In the meantime, the population of *Artogeia canidia*, another *Lepidium virginicum* feeder, was not affected, so *canidia* probably feeds on something else in addition to *L. virginicum*. This is not unusual, as *canidia* has been known from Kumaon since butterfly records began.

Varshney (1993) recorded seeds of *Reseda* (Resedaceae), *Turritis*, *Sisymbrium*, *Sinapis* and *Alyssum* (all Cruciferae) as larval host plants of the genus, evidently non-Indian records. Gupta (1968) recorded species of *Turritis* Linn. and *Arabidopsis* Schur. from Nainital. However, *daplidice* does not appear to feed on these plants here, judging by its population decline corresponding with the decline of *Lepidium virginicum*. It is an observed fact that the population of *daplidice* declined soon after the decline of *L. virginicum* and subsequently both taxa recovered.

In July 1999, although the southwest monsoon was in progress, *Lepidium virginicum* had not germinated in areas where it was common the previous year, and it was only to be found on a limited scale in irrigated areas. In 2000, the inevitable re-colonisation of degraded areas by this weed was followed by a corresponding increase in the *daplidice* population, so that by 2002, *daplidice* was as common as it was prior to 1999.

Pontia daplidice moorei Roeber is distinguished from the nominate subspecies by being a very large form. The population of *daplidice* from Kumaon is assigned to *moorei* on the basis of the relatively large size of the majority of individuals and the contiguous distribution of the two populations.

Peile (1937) collected a female with a wing expanse of 65 mm at Peshawar (Pakistan), now in the collection of the Natural History Museum, London, U.K. Hence, he gave the expanse of this subspecies as 45 to 65 mm; while Wynter-Blyth (1957), whose work was published twenty years later than Peile's, followed Evans (op. cit.) in assigning 45 to 50 mm. Specimens from Kumaon have a wing expanse up to 58 mm. One specimen taken in June has an expanse of 42 mm. Therefore, the wing expanse of this subspecies ought to be from 42 to 65 mm.

The records of *P. glauconome* from Mussoorie and Bhimtal are quite certainly stragglers from further west, but it is uncertain how much further west. The question is, is there a breeding population of *glauconome* in the plains of western India, or are the two specimens recorded from the known populations now in Pakistan? Both possibilities are equally likely, since this is a genus of strong fliers and migrants. Similarly, the breeding or migrant status of *P. chloridice* in the Kumaon and Garhwal Himalaya requires clarification.

The present records of *glauconome* are of interest since it has a rather restricted distribution in this area compared with other members of the genus. It occurs from east Africa to Chitral and Karachi in Pakistan. Given that it is capable of travelling as far east as Kumaon, its comparatively restricted distribution may be

attributed to its inability to breed in areas which are not completely favourable. In other words, it is not as resilient a species as the other members of the genus, although individuals are capable of travelling a considerable distance.

Unlike the other two members of the genus, *glauconome* is a low elevation butterfly that has colonised the warm, dry and low areas of Pakistan and other parts of its range, but seems to be unable to tolerate wetter regions such as Kumaon. *P. daplidice*, on the other hand, has given a new dimension to generic preferences by colonising and thriving in the heavy rainfall areas of Kumaon, which are well within the sub-tropical monsoon zone.

Almost all the Lepidoptera that appear to have colonised or migrated to Kumaon recently belong to the Indo-Malayan fauna (Smetacek 1994, 1995, 2001, unpublished data). The colonisation of the outer ranges of Kumaon by *daplidice* is of interest, since it is generally considered a Palaearctic taxon. This extension goes against the apparent trend, where the Central and Western Himalaya are getting warmer and wetter (Myers 1985) and consequently more conducive to colonisation by Indo-Malayan species (Smetacek 1994).

Wynter-Blyth (1957) noted that *daplidice* is primarily an inhabitant of the high inner hills, common at high altitude. In my experience, it is common at moderate elevation, i.e. between 1,200 m to 2,500 m, and less so above. As a matter of fact, I have never found it above 3,000 m in Kumaon or Garhwal. Also, I have found it to be commoner in the outer range than in the main Himalayan range. In the main range, I have found it in open river valleys near cultivation, rather than on hillsides or ridges at high elevation. Being a strong flier and quite a migrant, it might occasionally be found at high elevation like *Catopsilia pomona* Fabricius (Smetacek 1993), but it seems generally that above the tree line it is merely a straggler.

Conclusion

From the above account, it is evident that the distribution of two members of the genus *Pontia*, i.e. *daplidice* and *glauconome*, has extended to the Kumaon Himalaya, the former as a colonist and the latter as a straggling migrant. The colonisation of this area by *daplidice* appears to be quite recent, probably in the middle of the 20th century. It seems that the major factor behind its increased range is the spread of the North American plant, *Lepidium virginicum*, which was introduced to India, probably in grain shipments in the post-Independence period.

P. daplidice has been bred on this plant in Kumaon, and in 1999, populations of *daplidice* in the area fell sharply at the same time as this plant failed to germinate in places where it was common, mainly due to meagre winter rains. It is interesting that the lack of a suitable larval host plant rather than a climatic factor appears to have restricted the distribution of *daplidice* to the Palaearctic Region. The self-introduction of a suitable host plant has resulted in the colonisation by *daplidice* of Kumaon, which is known as the mixing zone between the Palaearctic and Indo-Malayan faunas. The possibility of it extending its distribution further east in the coming years cannot be ruled out.

In the present context of global warming, the extension of range of a typically Palaearctic genus into the transitional zone represented by Kumaon is unusual.

Acknowledgements

I am grateful to Professor Y.P.S. Pangtey of Thakur D.S.B. Constituent College, Nainital, for kindly identifying the larval host plant of *P. daplidice*, as well as to the editor and anonymous referees for their valuable suggestions.

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A COLLECTION OF *FRULLANIA* FROM NILGIRI WITH *F. DENSILOBA* ST. AS A NEW RECORD FOR INDIA[1]

S.C. Srivastava and Afroz Alam[2]

(*With two text-figures*)

Key words: Bryophyta, Hepaticae, Jungermanniales, Jubulaceae, *Frullania densiloba*

Frullania densiloba St. is reported for the first time, not only from India, but also from Tropical Asia, along with the other species of *Frullania* distributed in the Nilgiri hill ranges. A key to segregate various species of *Frullania* from Nilgiri is provided.

The present communication is based exclusively on a collection of *Frullania* from the Nilgiri hill ranges to evaluate the frequency and variety of the genus in this area. *Frullania* shows a very high level of structural diversity and often becomes a puzzle in species determination. Apart from its morphological diversity, each species can be recognized by its typical lobule, presence and absence of ocelli, perianth morphology, leaf lobe shape and underleaves.

While working on the collection of the genus from the Nilgiris, an interesting ocellate species of *Frullania* other than *Frullania tamarisci*, a well-known ocellate species from Nilgiri and other regions of South India was in hand. On critical study, this plant showed very close resemblance to *Frullania densiloba* St., a species distributed in Eastern Asiatic temperate region (including Japan, Ryukyu, Formosa, Quelpart, Botel Tobago) (Kamimura 1961) and clearly different from *Frullania tamarisci*. The discovery of *F. densiloba* from the Nilgiris thus constitutes a new record, not only from India but also from Tropical Asia.

A key to segregate various species of *Frullania* of the Nilgiris is provided along with an illustrated morpho-taxonomic account of *F. densiloba*.

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Key to the Species

1. Plant dioecious 2
— Plant monoecious 3
2. Leaf-lobes ocellate (with ocelli) 4
— Leaf-lobes non-ocellate (without ocelli) 5
3. Leaf-lobule helmet shaped, perianth 4-5 keeled .... *F. wallichiana*
— Leaf-lobule large, cucullate to subcucullate, perianth usually 4 keeled .... *F. neurota*
4. Leaf-lobes acute to acuminate, rarely obtuse to rounded, ocelli in 1-2 rows, 10-20 cells long, lobule saccate, subparallel with the stem and not inclined, slightly apart from the stem, female inflorescence terminal on short lateral branches, underleaves bifid, much wider than the stem, sinus obtuse .... *F. tamarisci*
4. Leaf-lobes slightly concave, ovate, with rounded apex, ocelli in a single row, less than 10 cells long, lobule clavate, almost parallel with the stem and inclined towards the stem, female inflorescence terminal on a leading branch, underleaves bifid, as wide as stem or slightly wider than the stem, sinus acute .... *F. densiloba*
5. Leaf-lobes squarrose .... *F. squarrosa*
— Leaf-lobes ovate with obtuse or rounded apex 6
6. Rostrum of leaf-lobule elongated which forms a piliferous beak .... *F. acutiloba*
— Leaf-lobules usually without rostrum 7
7. Leaf-lobules variable in shape, explanate to saccate, perianth ovoid, 5 keeled .... *F. muscicola*
— Leaf-lobules campanulate, perianth pyriform, usually 4 keeled .... *F. campanulata*

Frullania densiloba St. Species Hepaticarum IV: 549-550 (1909); Kamimura, Jour. Hattori Bot. Lab. No. 24: 69-73 (1961).

Plants small, 10.3-13.6 mm in length, brownish, having characteristic *Frullania*-type branching, stem rounded (in a cross section), 0.06-0.07 mm in diameter, differentiated into distinct cortical and medullary zone, cortical cells 6.3-7.6 x 3.1-3.8 μm, medullary cells 22.3-26.6 x 13.4-15.2 μm and are relatively larger than cortical cells. Leaves complicate bilobed, leaf lobe concave, ovate with somewhat rounded apex, contiguous to loosely imbricate, 0.28-0.32 mm long and 0.20-0.24 mm wide, apical cells of lobe 11.4-15.2 x 7.6-11.4 μm, median and basal cells 15.2-22.8 x 7.8-11.4 μm with thickened walls, trigones not clear, ocelli 4-8 in number, uniseriate to scattered, 22.8-26.6 x 19.0-21.3 μm, oil bodies not seen. Leaf-lobules almost parallel with the stem and about half of its own width covering the stem (i.e. slightly inclined towards the stem), clavate, 0.15-0.16 mm long and 0.08-0.11 mm wide, mouth rounded, stylus 4-celled, 25.3-28.2 μm long and 11.3-15.2 μm wide. Underleaves cauline, distant, transversely inserted, oblong, lateral margin almost parallel to the stem, 0.10-0.12 mm long and 0.068-0.070 mm wide, apex bilobed up to half of its length, sinus acute.

Dioecious (Figs 1, 2). Male inflorescence nearly globose on short lateral branches, bracteoles restricted to the base of inflorescence, bracts in 2-3 pairs, ovate, 0.52 mm long and 0.44 mm wide, apical cells of bract 7.5-17.5 x 6.25-12.5 μm, median and basal cells 7.5-12.5 x 12.5-22.5 μm, male bracteoles bilobed 157.2-162.5 μm long and 51-55 μm wide. Female inflorescence terminal, bracts three, bract lobe ovate to oblong with conspicuous dentitions at margin, 0.57 mm long and 0.32 mm wide, at fully stretched condition, 0.77 mm long and 0.55 mm wide, bracteoles bilobed to about half of its length, sinus narrow, two or three in number, 0.49 mm long and 0.24 mm wide, at fully stretched condition 0.53 mm long and 0.33 mm wide, dentate. Perianth almost one fourth to half emergent, 3.5-3.9 mm long and 1.64-1.76 mm wide, obovate, 3-keeled (2 lateral and 1 ventral), apex rounded with a distinct rostrum.

Distribution and Ecology: Corticolous epiphyte, being reported for the first time from South India: Tamil Nadu: Nilgiri: Ootacamund, Dodabetta peak.

Grows with *Plagiochila* sp., *Drepanolejeunea* sp., *Leucolejeunea* sp., *Radula* sp., *Frullania tamarisci* between 2,300-2,600 m, temperature ranging between 10-25 °C, with annual rainfall up to 400 cm.

Range: Japan, Quelpart, Ryukyu, Formosa, Botel Tobago, India.

Specimens examined: India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta, Leg.: P.K. Verma and A. Alam, Det.: S.C. Srivastava and A. Alam. LWU-13453/2001, 13477/2001.

The following species of *Frullania* have been observed along with *F. densiloba* St. in the collection from Nilgiris. (See Parihar *et al.* 1994, Nath and Asthana 1998). All these species listed below were reported earlier from Sikkim Himalayas (Mitten 1861) except *F. campanulata* (Chopra 1938) and *F. acutiloba* (Mitten 1861) which were reported from South India.

1. ***Frullania tamarisci*** (L.) Dum. Sde. Lac. in Miquel, Ann. Mus. Lugd- Batavi 1: 313(1836).

Basionym: *Jungermannia tamarisci* L., Sp. Pl. 1134 (1753).

Characteristics of species: Dioecious, with saccate lobule, ocelli in 1-2 rows, 10-20 cells long, rarely scattered, and 3 keeled perianth.

Distribution and Ecology: Very common in Nilgiri hills and elsewhere, South India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta peak, Government Botanical Garden, Pykara, Avalanche. Grows on tree bark associated with *Plagiochila* sp., *Leucolejeunea* sp., *Lophocolea* sp., *Frullania neurota*, *F. squarrosa* and *F. densiloba*.

Range: Japan, Korea, China, Formosa, Philippines, India, Ceylon.

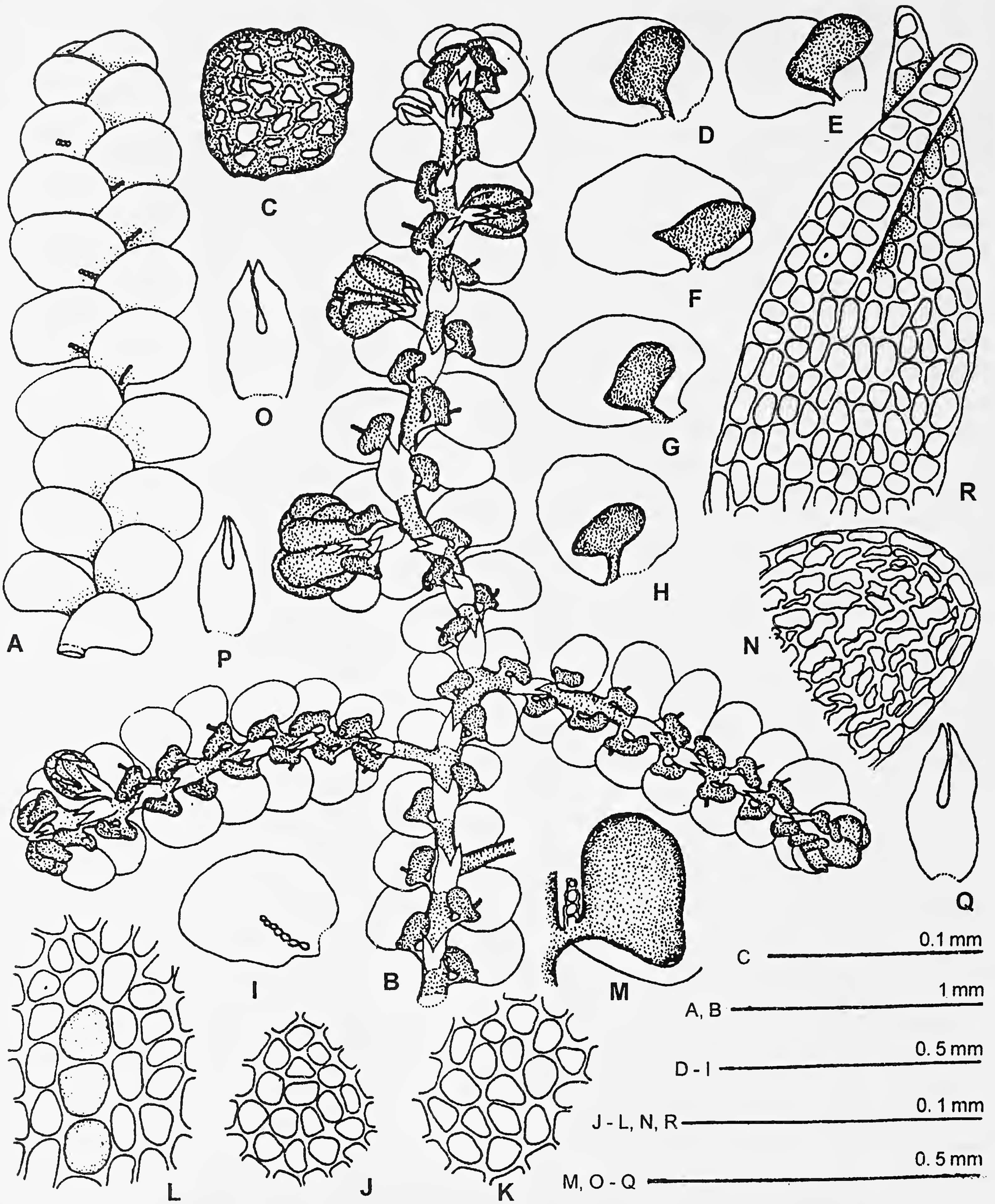

Fig. 1: *Frullania densiloba* St., A. Male plant (dorsal view), B. Male plant (ventral view), C. T.S. of stem, D-H. Leaf-lobes with lobules, I. Leaf-lobe with ocelli, J. Apical cells of leaf-lobe, K. Median cells of leaf-lobe, L. Basal cells of leaf-lobe, M. Leaf-lobule with stylus, N. Cells of lobule, O-Q. Underleaves, R. Underleaf (cellular)

Specimens examined: India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta: LWU - 6863/82, 6873/82, 6885/82, 6889/82, 6892/82, 6896-97/82, 6900-01/82, 6903/82, 6934/82, 6938/82, 6946/82, 6949/82, 6952-55/82, 6957-58/82, 6969/82; 12432-33/2000, 12462/2000, 13451/01, 13455/01, 13464/01, 13480-81/01, 13484/01; Government Botanical Garden: LWU-6974/82; Pykara: LWU-12672/2000, 12704/2000, 12748/2000; Avalanche: LWU-12544/2000, 12553/2000.

2. ***Frullania wallichiana*** Mitt. Proc. Linn. Soc. 5. 118(1861)

Characteristics of species: Monoecious, with helmet shaped, large lobule and 4-5 keeled cylindrical perianth.

Distribution and Ecology: South India: Tamil Nadu: Nilgiri: Pykara, Krutukuli. Plants grow on bark of trees with *Ptychanthus striatus* and *Lejeunea* sp.

Range: Himalayas, India, Sri Lanka, Sumatra, Java, Philippines, Africa, Central and South America, New Guinea.

Specimens examined: India: Tamil Nadu: Nilgiri: Pykara: LWU-12607/2000, 12675/2000, 12691-92/2000, 12699/2000, 12714/2000, 12715/2000, 12722/2000, 12755-58/2000, 12760/2000, 12761/2000; Krutukuli: LWU-13709/2001.

3. ***Frullania neurota*** Tayl. J. Bot. 5: 400 (1846)

Characteristics of species: Monoecious, lobules large, cucullate or subcucullate, without beak, perianth 4 keeled.

Distribution and Ecology: South India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta, Government Botanical Garden, Soil and Water Conservation Institute (SWCI) Road, Krutukuli, Pykara, Avalanche. Grows on tree bark in association with *Radula* sp., *Lophocolea* sp., *Frullania campanulata*, *Frullania tamarisci*, and *Frullania wallichiana.*

Range: Widely distributed in tropical Asia, Hawaii, Mexico, India.

Specimens examined: India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta: LWU-6874/82, 6905/82, 6916/82, 6921/82, 6953/82, 6962/82, 6963/82, 6964/82; 12411/2000, 12414/2000, 12422/2000, 12424/2000, 12440/2000, 12459/2000, 12479/2000, 12487-88/2000, 13455/2001, 13464/2001, 13480-84/2001, 13486/2001; Government Botanical Garden: LWU-6974/82, 6987/82, 6988/82, 6989/82, 6991/82, 12791/2000, 12796/2000, 12803/2000. Pykara: 12667/2000, 12672/2000, 12677/2000, 12678/2000, 12683/2000, 12684/2000, 12689/2000, 12692/2000, 12693/2000, 12700/2000, 12714/2000, 12758/2000, 12761/2000, 12769/2000, 12783/2000; Avalanche: 12568/2000, 12590/2000, 12613/2000, 12623/2000, 12665/2000; Soil and Water Conservation Institute (SWCI) Road: 13709/2001. Krutukuli: 13701/2001, 13702/2001, 13704/2001, 13705-06/2001, 13712/2001, 13714/2001, 13715/2001, 13724/2001, 13730/2001.

4. ***Frullania squarrosa*** (R., Bl. *et* Nees) Dum. Rec, d'obs 13(1835)

Basionym: *Jungermannia squarrosa* R., Bl. *et* Nees Nova Acta Acad. Caes. Leop. Carol. 12: 219 (1824)

Characteristics of species: Dioecious, leaves squarrose, saccate, with helmet-shaped leaf lobules variable in size and 3-keeled perianth.

Distribution and Ecology: South India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta, Government Botanical Garden, Soil and Water Conservation Institute (SWCI) Road, Pykara, Avalanche, Krutukuli. Plants grow on soil as well as tree bark in association with *Lophocolea* sp., and *Lejeunea* sp.

Range: Widely distributed in warm-temperate regions of the world.

Specimens examined: India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta: LWU-6885/82, 6890/82; 13464/01. Government Botanical Garden: LWU-12803/2000; Pykara: LWU-12758/2000, 12759/2000; Avalanche: LWU-

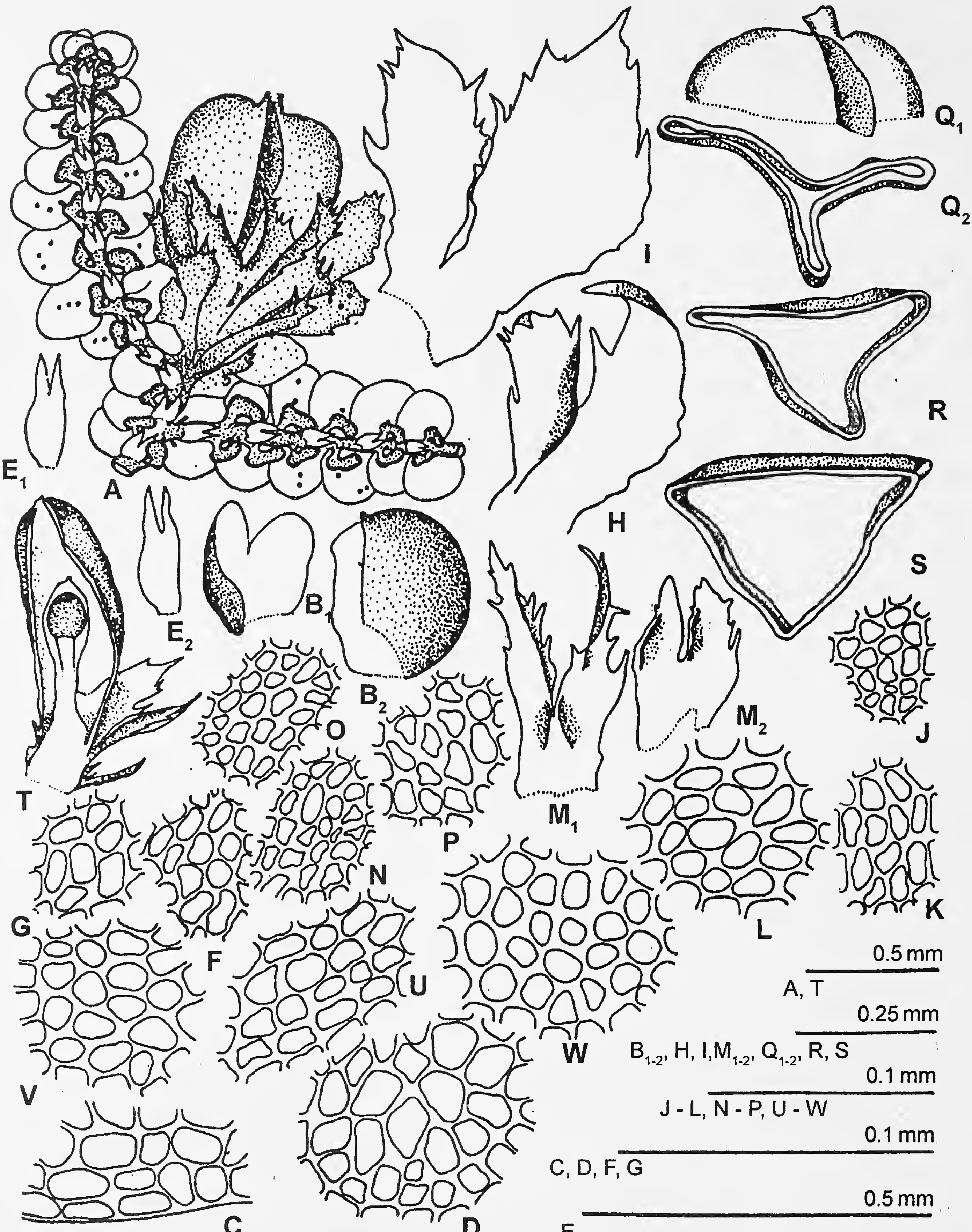

Fig. 2: *Frullania densiloba* St., A. Female plant (Ventral view), B_{1-2}. Male bracts, C. Apical cells of male bract, D. Median cells of male bract, E_{1-2}. Male bracteoles, F. Apical cells of male bracteole, G. Median-basal cells of male bracteole, H. Female bract. I. Female bract (stretched), J. Apical cells of female bract, K. Median cells of female bract, L. Basal cells of female bract, M_{1-2}. Female bracteoles, N. Apical cells of female bracteoles, O. Median cells of female bracteole, P. Basal cells of female bracteole, Q_{1-2}. T.S. of perianth (Apical portion), R. T.S. of perianth (Middle portion), S. T.S. of perianth (Basal portion), T. L.S. of perianth, U. Apical cells of perianth, V. Median cells of perianth, W. Basal cells of perianth

12595/2000; Krutukuli: LWU-13701/2001, 13707/2001, 13710/2001, 13711/2001.

5. ***Frullania muscicola*** St., Hedwigia 33: 146(1894)

Characteristics of species: Dioecious, leaf lobule saccate with 5 to 6 keeled perianth.

Distribution and Ecology: South India: Tamil Nadu: Nilgiri: Ootacamund Dodabetta, Government Botanical Garden, Pykara, Avalanche, Krutukuli. Plants grow on tree bark and also on soil with *Plagiochila* sp., *Radula* sp., *Lophocolea* sp., *Lejeunea* sp., *Frullania squarrosa*, and *F. tamarisci.*

Range: China, Himalayas, India.

Specimens examined: India, Tamil Nadu: Nilgiri: Ootacamund: Dodabetta: LWU-6880/82, 6903/82, 6923/82, 6953/82, 6960/82, Government Botanical Garden: LWU-6978/82, 6994/82, 7029/82, 7035/82; Pykara: LWU-12686/2000, 12727/2000, 12748/2000, 12760/2000; Avalanche: LWU-12644/2000; Krutukuli: LWU-13711/2001.

6. ***Frullania campanulata*** Sde. Lac. Nederi. Kruidk. Arch 3: 422(1854).

Characteristics of Species: Dioecious, leaf lobule campanulate, longer than broad, perianth 4-keeled, with smooth surface.

Distribution and Ecology: South India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta, Government Botanical Garden, Soil and Water Conservation Institute (SWCI) Road, Pykara, Avalanche. Epiphyte, grows in association with *Microlejeunea* sp. *Radula* sp., *Frullania neurota*, *Frullania tamarisci*, *Metzgeria* sp., and *Plagiochila* sp.

Range: Sumatra, Java, India.

Specimens examined: India, Tamil Nadu: Nilgiri: Ootacamund: Dodabetta: LWU-6873/82, 6888/82, 6909/82, 6917/82, 6930/82, 6954/82, 6962/82, 6963-64/82; 12411/2000, 12414/2000, 12422/2000, 12424/2000, 12440/2000, 12459/2000, 12479/2000, 12487/2000, 12488/2000, Government Botanical Garden: 6987/82, 6988/82, 6989/82; Pykara: LWU-12668/2000, 12696/2000, 12697/2000, 12721/2000, 12744/2000, 12750/2000, 12760/2000, 12764/2000; Avalanche: LWU-12571/2000, Soil and Water Conservation Institute (SWCI) Road: LWU-12379/2000, 12388/2000, 13701/2001, 13711/2001; Theetukal: LWU-13714/2001.

7. ***Frullania acutiloba*** Mitt., Proc. Linn. Soc. 5: 120(1861).

Characteristics of species: Dioecious, leaf lobule explanate to helmet-shaped, large with piliferous beak, perianth 3-keeled.

Distribution and Ecology: South India: Tamil Nadu: Nilgiri: Ootacamund: Dodabetta, Government Botanical Garden, Theetukal. Epiphyte, associated with *Cheilolejeunea* sp., *Radula* sp., *Metzgeria* sp., *Frullania tamarisci* and *F. squarrosa.*

Range: India, Ceylon, Java.

Specimens examined: India, Tamil Nadu: Nilgiri: Ootacamund: Dodabetta: LWU-6934/82, 6952/82, Government Botanical Garden: LWU-12808/2000; Theetukal: LWU-13720/01, 13721/01, 13722/01, 13724/01, 13726/01.

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DEBARKING OF TEAK *TECTONA GRANDIS* LINN. F. BY GAUR *BOS GAURUS* H. SMITH DURING SUMMER IN A TROPICAL DRY DECIDUOUS HABITAT OF CENTRAL INDIA[1]

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Key words: Food habits, debarking, gaur, *Bos gaurus*, Madhya Pradesh, teak, *Tectona grandis*, bark feeding

Debarking of teak trees *Tectona grandis* Linn. f. by gaur *Bos gaurus* H. Smith was studied during the summer of 1996 in the Pench Tiger Reserve, Madhya Pradesh. Seven one-hectare vegetation plots were sampled within the summer ranging areas of the gaur to quantify and determine the extent of debarking. Of the sampled trees, 39% were debarked, 73% of which had low level of debarking. The teak trees of different girth classes were not debarked in proportion to their availability. No mortality was observed amongst the debarked trees. A maximum of 26.6% crude protein was recorded from the bark samples. Amongst the minerals found in the teak bark, calcium was the major constituent, followed by sodium, iron, manganese and copper. Of the food plants eaten by the gaur, teak bark was consumed most (14%). The moisture content in the teak bark varied from 25 to 80%. Consumption of the high protein, calcium- and potassium-rich teak bark would be beneficial to the gaur especially during the dry months when food resources are limited. Further analysis of the bark samples of teak and other food plants of the gaur, for secondary compounds and nutritional quality, would enable a better understanding of the debarking behaviour of the gaur.

Introduction

The selection of food plants by herbivores could be due to the presence of soluble carbohydrates, proteins, plant fibre, minerals, vitamins, secondary compounds and organic acids (Westoby 1978). To obtain these nutrients, the animals consume different parts of the plants like leaves, twigs, roots, floral parts and bark. Bark feeding is a well-known phenomenon among groups of mammals such as rodents, lagomorphs, ungulates, proboscides and primates (Curtis 1941, McKay 1973, Laws *et al.* 1975, Vancuylenberg 1977, Sullivan and Sullivan 1982, Prior 1984, Kenward and Parish 1986, Borges 1989, Sukumar 1989, Joshua 1992, Sharma and Prasad 1992, and Khan *et al.* 1994).

The existing information on the debarking habits of gaur (*Bos gaurus*) is so far mainly anecdotal. The gaur is known to feed on the bark of *Adina cordifolia* (Brander 1923, Schaller 1967), *Holarrhena antidysentrica* (Ogilive 1954), *Tectona grandis* (Ranjitsinh 1997) and *Wendlandia natoniana* (Ogilive 1954).

Debarking of teak by gaur was studied between April and June 1996 in the Pench Tiger Reserve (PTR), Madhya Pradesh. Only teak trees were debarked by gaur and debarking of teak by other wild ungulates in the study area was not observed.

Study Area

Pench Tiger Reserve, PTR, (78° 55' to 79° 35' E and 21° 8' to 22° N) lies in the southern lower reaches of the Satpura hill range in the southwestern region of Madhya Pradesh. The Reserve with a total area of 757.85 sq. km comprises a wildlife sanctuary, national park and reserved forests.

In addition to gaur, the wild ungulates found in PTR are chital (*Axis axis*), sambar (*Cervus unicolor*), nilgai (*Boselaphus

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tragocamelus), barking deer (*Muntiacus muntjac*), chowsingha (*Tetraceros quadricornis*), chinkara (*Gazella gazella benneti*) and wild pig (*Sus scrofa*). The predators existing in the area are tiger (*Panthera tigris*), leopard (*P. pardus*) and wild dog (*Cuon alpinus*).

The Pench river flows in a north-south direction, dividing the Park into two almost equal halves. Due to the construction of a hydroelectric dam on the Pench river, 54 sq. km of the low-lying area on either side of the river has been submerged. During the summer months the river dries up, resulting in small water bodies which are vital for the survival of the gaur and other wild animals.

Climatically, the area has four seasons: summer (March-June), monsoon (July-August), post monsoon (September-October) and winter (November-February). The temperature ranges from a minimum of -2 °C at the height of winter to a maximum of 49 °C in peak summer. The average annual rainfall is 1,400 mm. The forest cover of the area has been classified as Tropical Dry Deciduous and Tropical Moist Deciduous types (Champion and Seth 1968). The dominant vegetation types include teak forest, teak-miscellaneous forest, miscellaneous forest, *Butea-Zizyphus* mixed woodland, *Anogeissus-Boswellia* mixed forest, *Cliestanthus collinus* forest and riverine forest. The terrain is gently undulating and criss-crossed by small streams, most of which are seasonal. The hills have gradual to steep slopes with almost flat tops. The mean altitude is 550 m.

Methods

Though teak trees were found all over the Tiger Reserve, they were debarked only in the summer ranges of the gaur, close to Pench river in the National Park. Based on a reconnaissance, seven one-hectare plots in an area of 40 sq. km were randomly selected within the summer ranges of the gaur, along the Pench river in the National Park, to quantify debarking. In each one-hectare plot, nine circular plots of 10 m radius at an interval of 25 m were sampled (n = 63) for the following data:

(a) Total number of trees of all species and their GBH (girth at breast height).

(b) The debarked area of the tree was calculated by taking the average width of the debarked portion at three different points along the debarked strip of the stem and multiplying it with the length of the debarked strip. The product obtained is multiplied with the constant π (3.14). In case of two separate portions debarked on the same tree, the area of each was calculated separately and summed to give the total area.

(c) The area from the base of the stem to the upper tip of the debarked strip was determined as the area available for debarking. This entire portion of the stem was assumed to be cylindrical. The surface area of this cylinder was calculated to obtain the available area (π dh, where: d = diameter of the stem at breast height, h = height from the ground to the tip of the debarked portion and π = constant 3.14).

(d) Extent of debarking (ED) was categorised into three classes, low (< 25% of the available area debarked), medium (25% to 50% of the available area debarked) and high (>50% of the available area debarked) and was calculated using the following formula:

$$ED = \frac{\text{Area Utilized}}{\text{Area Available}} \times 100$$

(e) Height at which debarking occurred from the ground.

The sampled teak trees were grouped into eight different girth classes (<21 cm, 21-40 cm, 41-60 cm, 61-80 cm, 81-100 cm, 101-120 cm, 121-140 cm, 141-180 cm) to analyze the utilization pattern of each girth class. To determine the difference in the expected and observed utilization patterns of different teak

girth classes, chi-square goodness of fit test (G) was used (White and Garrot 1990). To test the difference in proportionate use and availability for each girth class, 95% simultaneous confidence interval was calculated following Marcum and Loftsgaarden (1980). Student's t-test (Fowler and Cohen 1986) was used to detect the differences between mean density (trees/ha) of debarked and other food plant (trees) species in the plots sampled.

A total of 180 samples of teak bark representing nine girth classes were collected. The fresh weights of bark samples were taken in the field and then oven dried at 60 °C for 24 hours and weighed again. The difference in the fresh and the dry weight were estimated to determine the percent moisture content in the bark. All bark samples were tested for percent crude protein, ash content and calorific value (Allen 1989). Kjeldahl method (Allen 1989) was used to estimate the nitrogen content in the bark. The values of nitrogen expressed as percentage of dry weight were multiplied by a factor of 6.25 to obtain the percent protein (Cunnif 1995). Percent ash was estimated by combustion of a sample of known weight in a muffle furnace at 600 °C for 6 hours. The residue left after the combustion of organic matter in the sample, is the ash content for that species. The calorific value of the bark was estimated to get the gross energy (kcal/g) by igniting them in a Gallenkamp Ballistic Bomb Calorimeter. One bark sample representing the different girth classes was taken for the analysis of the minerals. The dried and ground samples were digested by the Mixed Acid Digestion Method and were analysed for calcium, copper, manganese and iron. Inductive Couple Plasma Emission Spectrophotometer (ICPS) was used for the analysis of the minerals (Allen 1989).

Data on the food habits of gaur was collected by opportunistic sightings. In total, 130 feeding observations were recorded. The food plant species and parts eaten were noted down for each observation. A total of 50 individuals of teak were tagged to monitor the mortality, if any, due to debarking by gaur.

Results

The teak trees were virtually leafless at the time when debarking was observed. Except calves, individuals of all age groups were observed feeding on the teak bark. Direct feeding observations (n = 130) showed that browse formed a major proportion of the diet of the gaur during summer (grass: browse ratio 1:3). A total of 11 tree, 3 shrub, 3 climber, 4 grass and 1 herb species were recorded as summer food plants of the gaur (Table 1). Among the plant parts eaten by gaur, teak bark was the most frequent (14%).

Table 1

FOOD PLANTS OF GAUR IN PENCH TIGER RESERVE (SUMMER 1996)

Plant forms	Plant parts	% Observations (n=130)
Trees		
Ougenia dalbergioides	L	10.0
Tectona grandis	B	14.0
Diospyros melanoxylon	L	6.0
Bauhinia racemosa	L	1.0
Grewia tiliaefolia	L, FL	3.0
Flacourtia ramontchii	L	1.5
Miliusa velutina	L	1.5
Aegle marmelos	L, FR	3.0
Bridelia retusa	L	6.0
Cordia myxa	L	1.5
Zizyphus xylopyra	L	2.0
Shrubs		
Grewia hirsuta	L, FL, FR	11.0
Barleria spp.	L	1.5
Helicteres isora	L	2.0
Climbers		
Ventilago madraspatana	L, FR	2.0
Bauhinia vahlii	L	6.0
Acacia pennata	L	0.7
Grasses		
Dendrocalamus strictus	L, SD	9.0
Cynodon dactylon	L	3.0
Heteropogon contortus	L	10.0
Herbs		
Sida spp.	L, FL, FR	2.0

(L = Leaf, FL = Flower, FR = Fruit, SD = Seed, B = Bark)

Of the 630 teak trees enumerated during the sampling, 247 were found debarked. The debarking by gaur among the eight girth classes of teak trees showed a significantly different ($G=67.3$, df=7, $p< 0.001$) utilization pattern (Table 2). The Simultaneous Confidence Interval identified girth class III (41-60 cm) as preferred, girth class II (21-40 cm) as avoided, and the trees of other girth classes used in proportion to their availability.

The mean density (trees/ha) of teak trees was high in debarked plots (Table 3) as compared to plots where debarking was absent ($t = 365.4$, d.f. = 61, $p< 0.0001$), whereas the mean density (trees/ha) of food plants (trees) of gaur in the debarked plots was significantly lower than that in the undebarked plots ($t = 540.3$, d.f. = 61, $p < 0.0001$).

The height at which gaur debarked the tree varied from 37.4 to 78.8 cm (average 69.2 cm). Of the total teak trees sampled, 39.2 % trees were debarked. The levels of debarking varied between girth classes. Of the total trees debarked (n=247), 73% were in the low, 21% in medium and 6% in high debarking category.

The estimated calorific value and the percent ash content in teak bark ranged from 3.1 to 4.3 kcal/gm and 8.8 to 16.4 % respectively. The percent crude protein varied between 7.7 and 26.6 %. The results of the analysis of the minerals in the bark are given in Table 4.

The water content among the nine girth classes varied from 25% to 80%. The mean water content estimated was 46.22% (SE ±9.01).

TABLE 2
PREFERENCE RATING OF DEBARKED TEAK TREES BY GAUR IN PENCH TIGER RESERVE

Class	GBH class	P_1	P_2	Confidence limits	R
I	<21	0.156	0.109	$-0.085\ P_1 = P_2\ 0.178$	0
II	21-40	0.580	0.356	$0.115\ P_1 > P_2\ 0.332$	-
III	41-60	0.126	0.275	$-0.271\ P_1 \leq P_2\ -0.028$	+
IV	61-80	0.053	0.069	$-0.152\ P_1 = P_2\ 0.1194$	0
V	81-100	0.046	0.093	$-0.181\ P_1 = P_2\ 0.087$	0
VI	101-120	0.024	0.073	$-0.185\ P_1 = P_2\ 0.087$	0
VII	121-140	0.008	0.012	$-0.144\ P_1 = P_2\ 0.135$	0
VIII	141-180	0.009	0.012	$-0.143\ P_1 = P_2\ 0.136$	0
n		931	247		

($G = 67.31$, d.f. = 7, $p<0.0001$)
P_1 = proportions available, P_2 = proportions utilized; n = number of trees in available and utilized categories; R = preference rating; (-) utilized less in proportion to its availability; (+) = utilized more in proportion to its availability; (0) = utilized in proportion to its availability

DISCUSSION

Several arguments have been put forth to explain the probable reason of debarking behaviour in the different species of mammals. The mammals may debark in response to shortage of food resource in an area (MacKinnon 1976), or shortage of mineral and trace elements required to meet their nutritional demand (Allen 1943, Bax and Sheldrik 1963, Croze 1974 and Vancuylenberg 1977), or for maintaining an optimum fibre: protein ratio for proper digestion of food and better assimilation of nutrients (Spinage 1994).

As the summer advances, most of the herbaceous layer in PTR dries up, resulting in poor quality of such resources. As a result, the gaur may turn to the available browse species and fibrous teak bark. In dry seasons, high fibrous diet increases the digestive efficiency by increasing the retention time of the food in the gut (Owen-Smith 1988) and also by decreasing the turnover rate of the rumen content (Bell

TABLE 3
MEAN DENSITY OF TEAK AND OTHER FOOD PLANTS (TREES) OF GAUR IN PENCH TIGER RESERVE

	Mean density of trees/ha	(S.E.)
Teak		
Debarked plots	446.5 /ha	(±125.3)
Undebarked plots	157.5 /ha	(±125.6)
($t = 365.4$, d.f. = 61, $p<0.0001$)		
Food plants (trees) other than teak		
Debarked plots	112.48 /ha	(±46.1)
Undebarked plots	380.30 /ha	(±54.8)
($t = 540.3$, d.f. = 61, $p<0.0001$)		

TABLE 4
TEAK BARK MINERAL CONTENTS
IN PENCH TIGER RESERVE (n=10)

Minerals	Range (ppm)	Mean (ppm)	S.E. ±
Ca	37,500-66,700	62,670.0	±4336.3
Na	400-750	590.0	±45.8
Fe	28-245	152.6	±18.7
Mn	19-26	20.0	±1.0
Cu	19-29	30.6	±5.5

1971). For the gaur, this may be one of the advantages of feeding on bark. The mineral contents of teak bark obtained from this study are similar to those reported by Tewari (1992) from other parts of central India. Teak bark being rich in protein and minerals, like calcium and sodium, would be beneficial to gaur. Requirement of minerals like calcium and phosphorus for ruminants ranges from 500 to 800 ppm and 300 to 450 ppm respectively (Webb 1988). The concentration of calcium in teak bark analyzed was 37,500-66,700 ppm. Tewari (1992) has also reported high concentration of calcium (22,400 ppm) and phosphorus (400 ppm) in the teak bark. Thus, consumption of teak bark would help the animal to satisfy its mineral needs and meet the food shortage to fulfil its physiological and nutritional requirements. High water content in the bark could be just an additional benefit to the animal in summer, when water becomes a limiting resource.

The results indicated that trees of different girth classes were debarked disproportionately to their availability. Such disproportionate use of resources can be termed as selective (Johnson 1980). Thus, high abundance of trees of one girth class did not necessarily result in high use. Areas with higher density of teak were preferred by gaur for debarking. The high tree availability perhaps provided better opportunities to feed selectively and reduced the time spent on searching. Also, by feeding in dense stands, the animals expend less energy per unit time (Curtis and Wilson 1943, Krebs and McCleery 1984). With the increase in the girth class of teak trees, the area debarked decreased i.e. the younger trees were debarked more than the older ones. This could be due to the fact that the bark of younger trees was softer and relatively less thick. Hence, it was easy for the gaur to strip the bark in large quantity and to reach the phloem and cambium layers that are rich in nutrients.

The bark consists of all tissues external to the vascular cambium (Esau 1967) and is composed of phloem, cortex, periderm, and remnants (if any) of the epidermis (Niklas 1999). The bark of a tree serves as a protective shield, insulating it against extremes of temperature, fire, desiccating wind, and against herbivory and microbial infections (Romberger *et. al.* 1992). Forest fire is known to affect the cambial tissue of trees (Uhl and Kauffman 1990, Hengst and Dawson 1993, Pinnard and Huffman 1997). During the study there were a few incidents of fire in the plots where debarking had taken place, but they were limited to the understory vegetation. No mortality of debarked trees was noticed as a result of the low intensity fire. Extensive damage caused by debarking is known to affect the radial growth of trees (Krefting *et. al.* 1962, Storm and Halverson 1967). In all debarked trees in the study area, the meristematic tissues of the stem grew over a period of time (6 months to 1 year) depending upon the intensity of debarking, and covered the exposed portion.

Incidents of debarking of teak by sambar (*Cervus unicolor*) were reported from Gir National Park, Gujarat (Khan *et al.* 1994), but in PTR, debarking of teak by wild ungulates other than gaur was not observed.

Since different nutrients tend to co-vary in their concentrations within plant tissues, depending upon the phenological stage of the plant (Westoby 1978), it is necessary to obtain the profile of the important minerals constituting teak bark at the different phenological stages of

teak. This will give a clue as to why gaur debark teak trees only in summer. Moreover, as noted by Owen Smith and Novellie (1982), one of the factors which is rebuttal for foraging performance is the food quality. The availability of secondary compounds in different plants in varying degrees also limits their palatability (Freeland and Janzen 1974). Further analysis of the bark samples of teak and other food plants for secondary compounds and nutritional quality would provide insights into the debarking behaviour of gaur.

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HABITAT PREFERENCE AND ENVIRONMENTAL RELATIONS OF *HYDROBIA* SP., MOLLUSCA: GASTROPODA, IN THE INTERTIDAL SUBSOIL OF A TROPICAL MANGROVE REGION[1]

R. Sunil Kumar[2]

(*With one text-figure*)

Key words: Mangrove, subsoil, ecology, estuary, intertidal area

Ecological distribution and pattern in population density of *Hydrobia* sp., a mud snail, both horizontally and vertically in the subsoil, is described in detail from intertidal areas of a tropical estuarine habitat. A maximum monthly density of 306/0.1 sq. m was recorded. Total density recorded was 281/0.1 sq. m at location 1 and 1,811/0.1 sq. m at location 2. The varying distribution and abundance among the two mangrove regions studied was noted. This variation may be correlated with the difference in texture and nature of the mangrove substratum. The drastic change of ecological factors, especially salinity, does not seem to influence the occurrence, showing the species' typical euryhaline behaviour. Maximum occurrence and density of this species was seen in the top 0-5 cm sediment stratum and apparently decreased towards the deeper part. High abundance of mangrove detritus is the cardinal factor favouring the habitat selection of the species. Its adaptability to the peculiar dynamic mangrove system helps its survival there.

Introduction

A variety of benthic organisms occupy the intertidal habitat of the tropical and subtropical mangrove regions of the world. The molluscan taxa form an important group among these benthic organisms (Kasinathan and Shanmugam 1985; Patra *et al.* 1990; Singh and Choudhury 1995; Alcantara and Weiss 1995; Schrijvers *et al.* 1995; Sheridan 1997; Yu *et al.* 1997; Sunil Kumar 1997, 1998). Molluscs are distributed in the topsoil as well as in the subsoil, and also as epibionts, attached to the submerged roots, timber and branches of mangrove vegetation. The present study describes the horizontal and vertical distribution pattern, ecological distribution and population structure of the mud snail *Hydrobia* sp. in the intertidal subsoil of Cochin mangroves in Kerala. The occurrence of *Hydrobia* sp. in the mangrove ecosystem of Cochin backwaters is being reported as a new record to the mangrove habitat of the Indo-Pacific region (Sunil Kumar 2001).

Material and Methods

Two fringing mangrove areas of Cochin backwaters, represented by the dominant mangals *Rhizophora mucronata* and *Avicennia officinalis* were selected for field collection. Monthly collections were taken for two years from September, 1989 to August 1991 from the intertidal area, namely low tide, mid tide and high tide regions. Triplicate soil samples, using a box corer (120 sq. cm), were made during the low tide period of the tidal cycle from the top 20 cm of the mangrove substratum. From this, the upper 15 cm length sample was taken for study. Collections from each tidal area were pooled and sieved through a 0.5 mm mesh sieve to separate the benthic organisms. Organisms were sorted, counted and the population density of *Hydrobia* sp. was determined and is expressed in number per 0.1 sq. m. Sand-silt-clay fractions

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of the soil (Krumbein and Pettijohn 1938) and organic matter (Walkley and Black 1934; El Wakeel and Riley 1957) were determined season-wise. Environmental factors were analysed monthly by standard methods (Strickland and Parsons 1977). For studying the vertical distribution of the species 20 cm sediment core sample were taken and each sample was cut into 0-5, 5-10 and 10-15 cm length. The 16-20 cm depth soil sample was not taken for the analysis. These 5 cm strata from three different depth levels were sieved separately and organisms counted.

Results and Discussion

Environmental factors

Of the various environmental factors studied, salinity fluctuated the most according to seasons; its distribution pattern in two locations is given (Fig. 1). The dissolved oxygen content ranged from 1.61 to 5.4 ml/l and 1.71 to 6.7 ml/1 at locations 1 and 2 respectively. The pH value of the sediment varied from 6.4 to 8.75 at location 1; 6.3 to 8.3 at location 2. The pH value of water ranged from 6.2 to 7.5 and 6.1 to 7.6 at locations 1 and 2 respectively. Sediment temperature varied from 28 to 33 °C at both locations. Water temperature varied from 30 to 33.5 °C at location 1 and 29 to 36 °C at location 2.

The sediment texture showed marked variations in the two study areas (Table 1). In general, sand was dominant, followed by silt and clay. Sediment type was sandy in the three tidal areas in all seasons at location 1. At location 2, it was clayey sand during pre-monsoon and post-monsoon, and silty sand during monsoon. Minor fractions of the sediment (silt, clay) were high at location 2.

The occurrence of *Hydrobia* sp. throughout the study period, despite changing salinity, clearly substantiates the typical euryhaline nature of the species. Varying salinity distribution pattern, and other abiotic factors such as temperature, dissolved oxygen and pH do not appear to affect its occurrence.

Horizontal distribution and population density

Population structure of *Hydrobia* sp. is given in Table 2. Of the two locations, the species showed a regular distribution pattern in location 2. Total density recorded was 281/0.1 sq. m and 1,811/0.1 sq. m at locations 1 and 2 respectively.

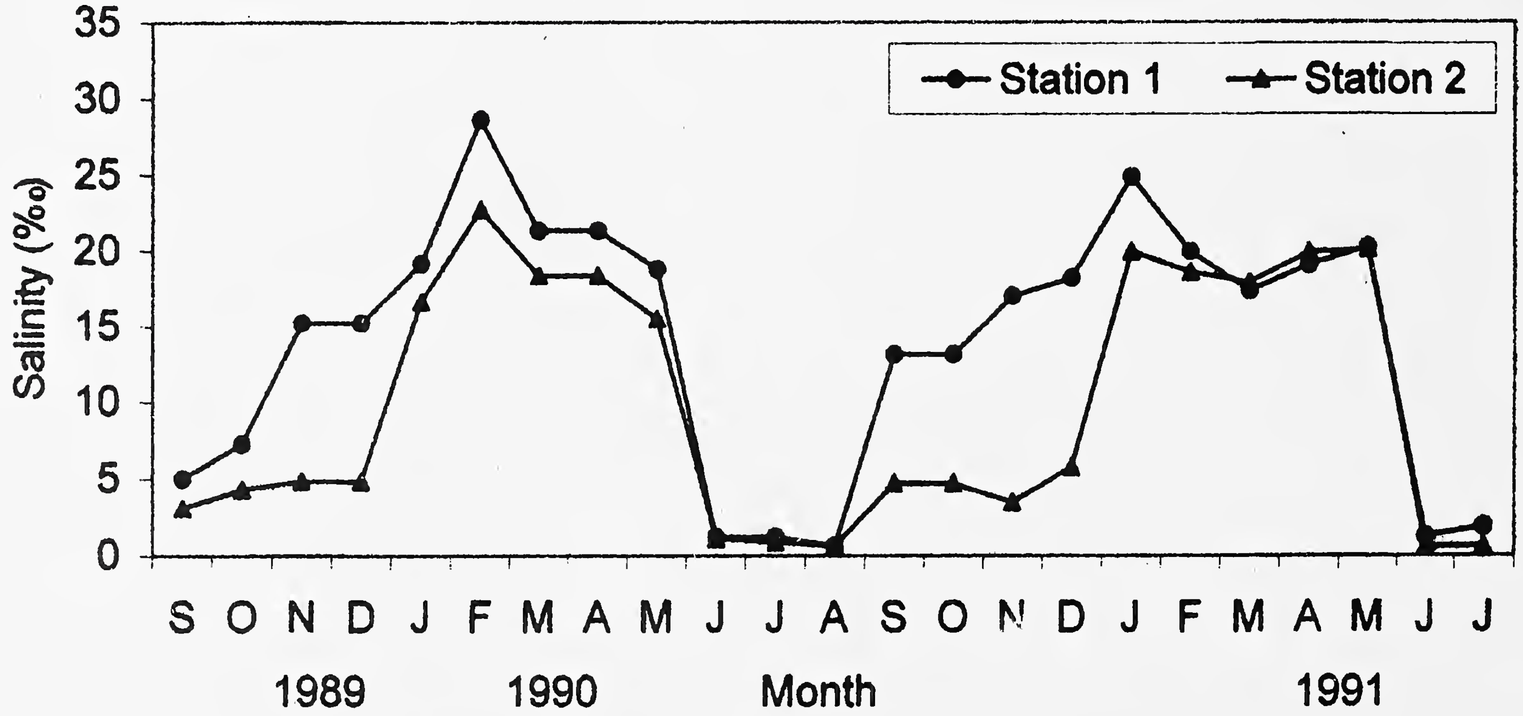

Fig 1: Monthly variation of salinity in the two locations

TABLE 1

SEDIMENT CHARACTERISTICS OF THE STUDY AREA IN DIFFERENT SEASONS (ALL VALUES EXCEPT pH in %)

	Pre-monsoon (February-May)					Monsoon (June-September)					Post-monsoon (October-January)				
	Sand	Silt	Clay	Organic carbon	pH	Sand	Silt	Clay	Organic carbon	pH	Sand	Silt	Clay	Organic carbon	pH
Location 1															
HTL	87.22	10.38	2.4	0.77	6.65	85.86	4.97	9.17	0.45	7.25	88.76	3.31	7.93	0.89	6.4
MTL	88.76	7.62	3.62	0.44	6.8	80.92	11.38	7.7	0.55	7.1	77.24	2.66	20.1	0.81	6.6
LTL	86.34	5.19	8.47	0.42	7.3	85.69	11.56	2.75	0.35	7.25	79.67	9.02	11.31	0.64	6.5
Location 2															
HTL	73.33	11.1	15.57	1.53	6.75	70.4	20.47	9.13	1.44	7.59	64.12	15.04	20.84	1.65	6.3
MTL	69.97	13.49	18.54	2.16	6.63	65.04	19.29	15.67	1.71	6.9	63.75	17.1	19.15	1.82	6.3
LTL	62.37	14.07	23.61	2.35	6.8	47.77	44.28	7.95	2.37	7.4	51.86	12.81	35.33	2.36	6.4

HTL = High tide level, MTL = Mid tide level, LTL = Low tide level

TABLE 2

POPULATION DENSITY (/0.1 SQ. M) OF *HYDROBIA* SP. IN THE LOW, MID AND HIGH TIDE REGIONS OF THE STUDY AREA

Year	1989			1990												1991					
Month	Sept	Oct	Nov	Jan	Feb	Mar	May	Jun	Jul	Aug	Sep	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Location 1																					
Low tide area	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	31	-	-	-	-	8
Mid tide area	17	22	-	-	-	3	8	-	-	11	25	-	-	6	6	8	3	6	-	-	-
High tide area	11	14	6	-	-	-	-	-	-	3	14	3	8	14	11	-	8	8	-	8	11
Location 2																					
Low tide area	25	17	31	19	-	25	56	8	-	3	28	56	33	22	306	19	14	22	94	-	6
Mid tide area	17	22	47	56	6	22	14	42	3	19	28	106	47	106	61	28	3	6	31	-	-
High tide area	-	28	17	33	-	39	56	42	3	31	-	33	19	17	22	11	3	6	-	-	3

Maximum monthly population density of 306/0.1 sq. m was recorded in February 1991, followed by 106/0.1 sq. m in November 1990 and January 1991 in location 2. The species showed no seasonal pattern in distribution.

A substantial variation in the distribution of the species was evident in the three tidal areas. At location 1, *Hydrobia* sp. population was 42.4%, 40.9% and 16.7% in the high, mid and low tide areas respectively, while at location 2, the population was 20%, 36.7% and 43.3% in the high, mid, and low tide areas respectively. A reduction in population density from high to low tide areas was thus seen at location 1, as opposed to an increase in population density from high to low tide areas at location 2. The greater numbers of the species in the low tide area of location 2 and high tide area of location 1 indicate that the tidal rhythm does not seem to influence the horizontal distribution and abundance of this infaunal mollusc. This suggests that the little more consolidated substratum of prolonged exposed high tide areas as well as the non-consolidated substratum, when only compared to high tide areas, of prolonged submerged low tide areas simultaneously favoured the occurrence of *Hydrobia* sp. Tidal cycle is a characteristic feature of the intertidal area. The exposed area above the mid-tide mark was more consolidated than the more submerged area of the low-tide mark. Therefore, the nature of the substratum apparently varies in the intertidal zone. *Hydrobia* sp. was distributed irrespective of the substratum.

Vertical distribution

The vertical distribution of *Hydrobia* sp. at location 2 is given in Table 3. Maximum density was found in the upper 0-5 cm sediment stratum. 63.3%, 15.1 % and 21.6% of the fauna was found at 0-5, 5-10 and 10-15 cm respectively. A maximum of 50/0.1 sq. m (in June, 1991) and 19/0.1 sq. m (in March, 1991) *Hydrobia* sp. were recorded in the deeper 10-15 cm stratum in comparison to the upper stratum of mangrove soil. Vertical distribution pattern of *Hydrobia* sp. reveals that the species can penetrate the soil down to 15 cm and beyond, showing its burrowing ability. High numerical abundance of the organisms in the 10-15 cm depth in comparison to the topsoil, only in two months (Table 3) and also its lower density at other periods of the study in deeper portion shows the capacity of *Hydrobia* sp. to survive in the deeper mangrove soil. Availability of detritus formation appears to be more pronounced in the surface sediment strata and this may coincide with the maximum abundance of species in the 0-5 cm sediment layer.

Hydrobia ulvae is a detritus- and deposit-feeder, and the difference in abundance of the species can be attributed to the nature of substratum in which they live (Newell 1965). It is suggested that the feeding habits increase with finer fractions of sediment. In the present study, the intertidal soil of the two mangrove areas was rich and thoroughly mixed with enormous detritus, while the substratum showed a characteristic difference in sand-silt-clay fractions. Finer fractions (silt and clay) of sediment and organic carbon were high at location 2, compared to location 1 and *Hydrobia* sp. showed dominance in the former area. Moreover, the concentration of organic carbon content pertains largely to the finer fractions of sediments (Sunil Kumar 1996). Food resource input as well as other ecological features of mangroves might be more or less similar in these two areas, whereas the mangrove substratum showed variability, reflecting the difference in distribution and numerical abundance of species.

Tidal influence, a cardinal factor as far as the distribution of various intertidal animals in different habitats is concerned, did not appear to be a limiting factor in the distribution of *Hydrobia* sp. in the present study. High abundance of detritus, the favourite food of *Hydrobia* sp., together with its euryhaline nature,

TABLE 3
POPULATION DENSITY (/0.1 SQ. M) OF *HYDROBIA* SP. IN THREE STRATA (0-5, 5-10, 10-15 CM) AT LOCATION 2

	Low tide area			Mid tide area			High tide area		
	0-5	5-10	10-15	0-5	5-10	10-15	0-5	5-10	10-15
March 1990	25	-	-	14	-	8	36	-	3
June	6	3	-	25	8	8	28	11	3
September	22	3	3	22	3	3	-	-	-
January 1991	11	8	3	92	11	3	6	6	6
March	17	3	-	3	6	19	6	-	6
June	22	22	50	22	3	6	-	-	-
August	6	-	-	-	-	-	-	-	3
Total	109	39	56	178	31	47	76	17	21

burrowing capacity and adaptations for survival towards deeper sediments are favourable factors responsible for the long-term occurrence and abundance of organisms in two different types of substrata. The study also reveals that *Hydrobia* sp. prefer the mangrove habitat of location 2, of which the top 0-5 cm layer of the soil provides the most suitable habitat.

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BARBULE STRUCTURE OF BIRD FEATHERS[1]

A. Rajaram[2]

(With five plates)

Key words: barbule morphology, bird-hits, bird taxonomy, feather microstructure, feathers

The structure of barbules from bird feathers has been studied by optical (bright field and polarized) and scanning electron microscopy (SEM). The factors which help in its identification are discussed and attention is drawn to similarities within related species and difficulties encountered.

Introduction

Optical microscopy of feather remnants has been employed to identify the species involved in bird-hit cases of aircraft (Rosalind and Grubh *JBNHS* 1987, *84*: 429-431). The general principle is that the nodal pattern on barbules, the colour at the nodes and their shape are characteristic of a species. The present paper is an extension of the work. In the case of bird-hits to aircraft, it is possible to identify the bird from other body parts, if they are in good condition. However, identification of a species solely on the basis of feathers is difficult; and analysis of the feather structure in greater detail is necessary. In addition to optical microscopy, where objects are viewed in a bright field, I have used polarized light microscopy and Scanning Electron Microscopy (SEM) to identify a species. A detailed study of this nature can help to identify birds involved in bird-hits, and also in taxonomy and in the control of trade in endangered species.

Materials and Methods

Samples were obtained fresh, usually feathers floating in the air, picked up as they hit the ground, from the bird under observation. Three samples (i.e. crow pheasant, house crow and Indian pitta) were of dead birds, but without any apparent putrefaction. Samples for light microscopy were prepared as follows: Barbule feathers were washed in 70% alcohol, then in absolute alcohol, rinsed in xylene and mounted on glass slides with DPX mountant under a coverslip. This resulted in poor contrast in white feathers, hence those samples were viewed in polarized light. For Scanning Electron Microscopy, samples bearing barbules were mounted on double sided sticking tape stuck on to aluminium stubs, given a thin coat of gold and viewed in a Cambridge Stereoscan S 150 or a JEOL 5600LV instrument at an accelerating voltage of 10 kV.

Results and Discussion

The micrographs obtained are shown in Figs 1-18. (Abbrev.: SEM = scanning electron micrograph, OMB = optical micrograph in bright field and OMP = optical micrograph in polarized light. The micron mark lines indicate 50 micrometres in the optical micrographs). Feather barbules from 18 species were studied. The SEM studies show surface features very well. Projections on the barbules are clearly seen. Fig. 1a is that of the Indian peafowl *Pavo cristatus*. The barbules are thick and the nodal projections are characteristic. The optical micrograph (Fig. 1b) shows some variations, depending on the plane of focus. Since the depth of focus, compared to the SEM, is very small for the optical microscope and we did not stain or take sections, we got an average effect, due to the thickness of the barbules. We noticed pigmentation in some regions, which was absent in other barbules, but a change in the focus point resulted in some contrast in these regions also. To the same observer, this would not be a problem as he would become aware of the variations possible, but in

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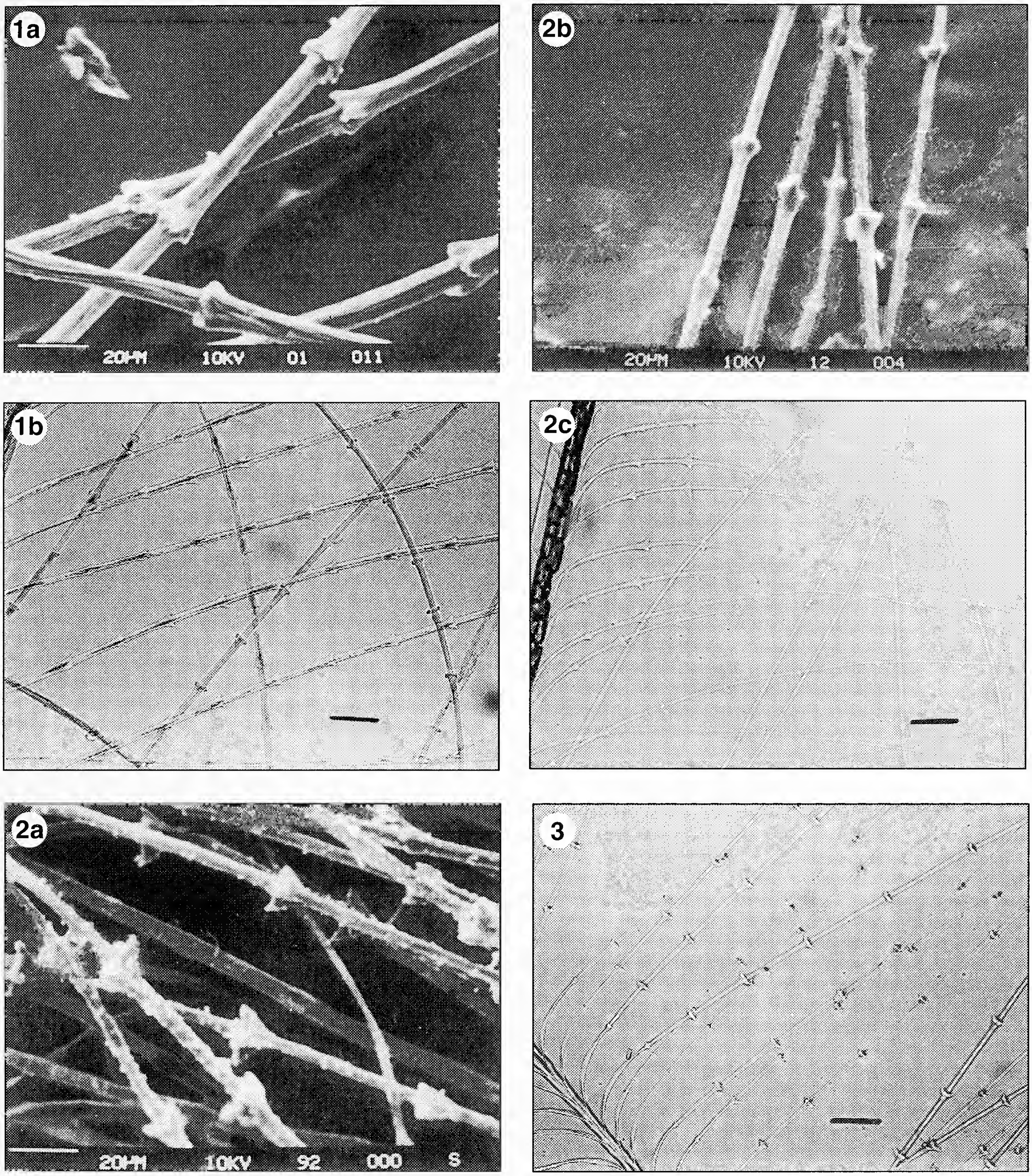
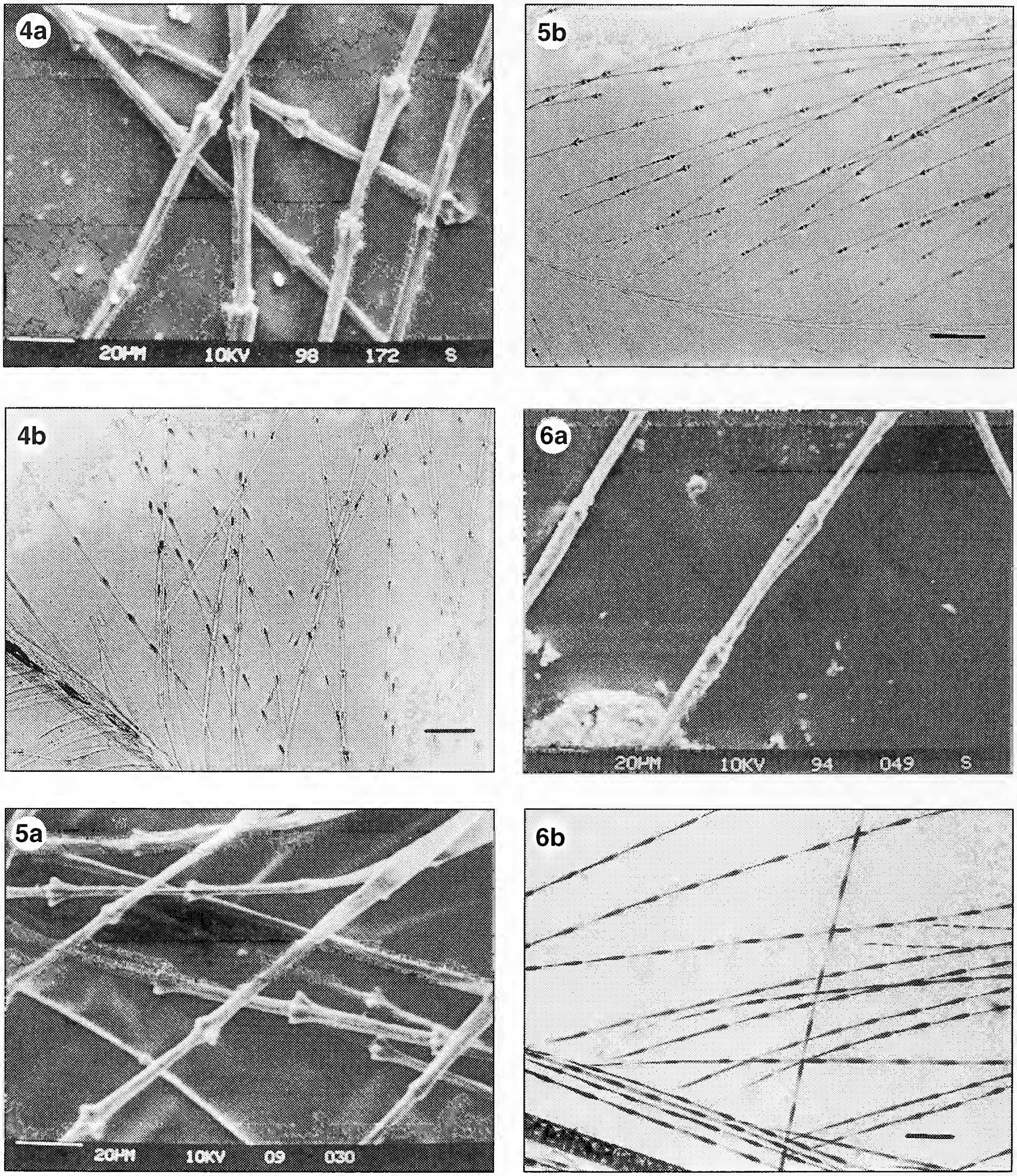
Rajaram, A.: Barbule structure PLATE 1



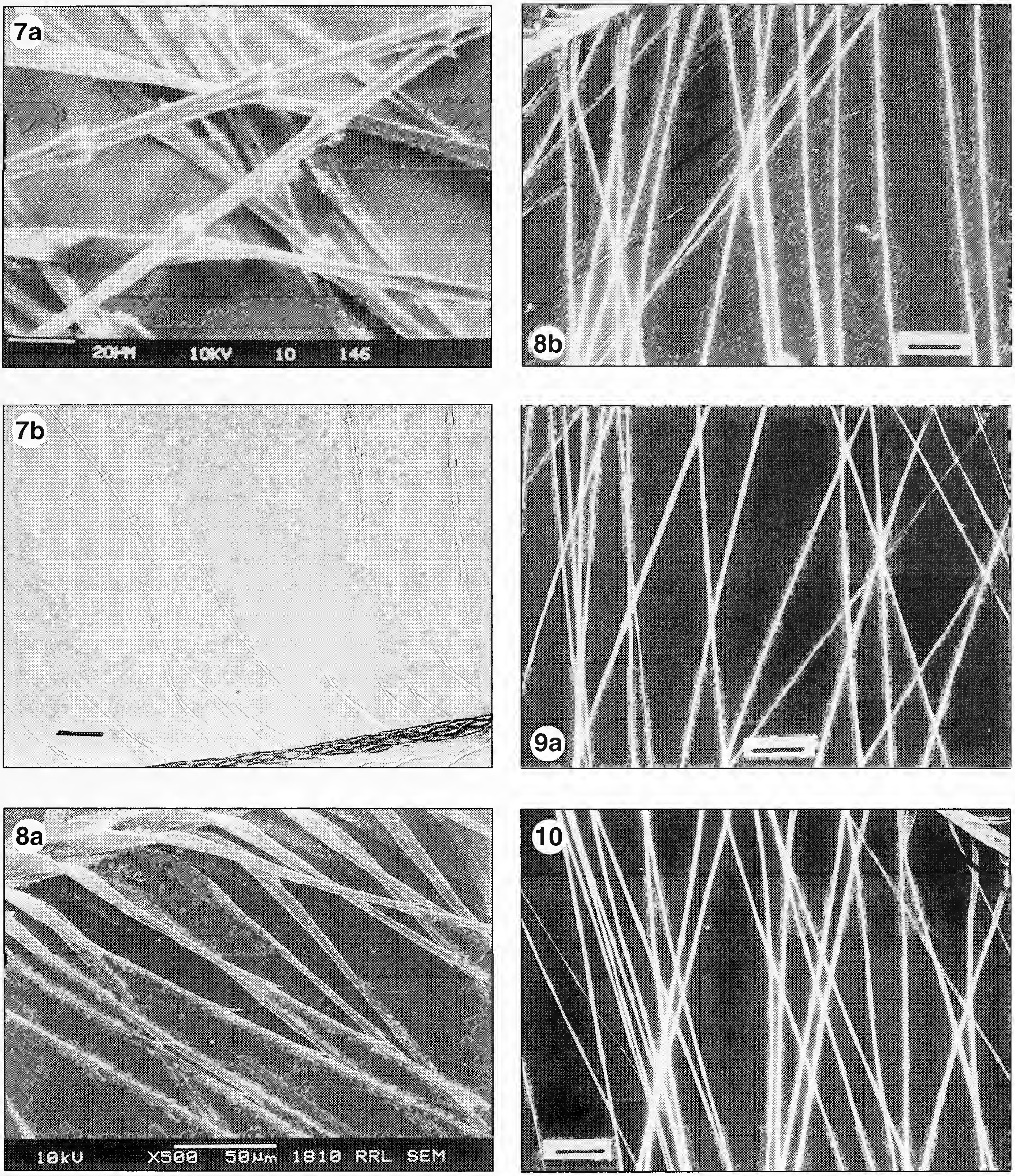
Figs 1-3: 1a. Indian peafowl (SEM), 1b. Indian peafowl (OMB), 2a. Blue rock pigeon (SEM), 2b. Blue rock pigeon (SEM), 2c. Blue rock pigeon (OMB), 3. Pompadour green-pigeon (OMB)

Rajaram, A.: Barbule structure

PLATE 2

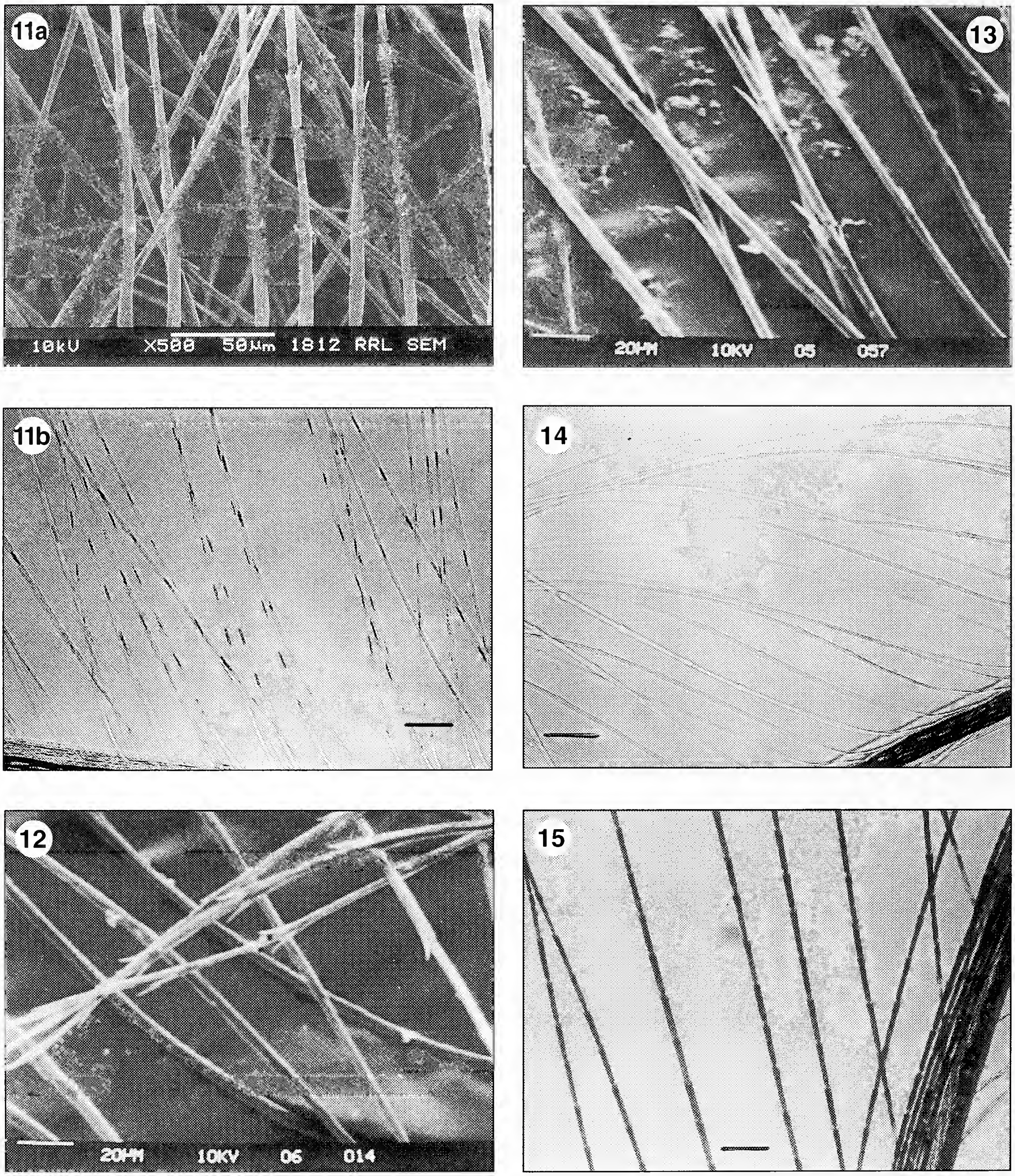


Figs 4-6: 4a. House crow (SEM), 4b. House crow (OMB), 5a. Common myna (SEM), 5b. Common myna (OMB), 6a. Indian pitta (SEM), 6b. Indian pitta (OMB)



Figs 7-10: 7a. Rose-ringed parakeet (SEM), 7b. Rose-ringed parakeet (OMB), 8a. Black-crowned night-heron (SEM), 8b. Black-crowned night-heron (OMP), 9. Cattle egret (OMP), 10. Median egret (OMP)

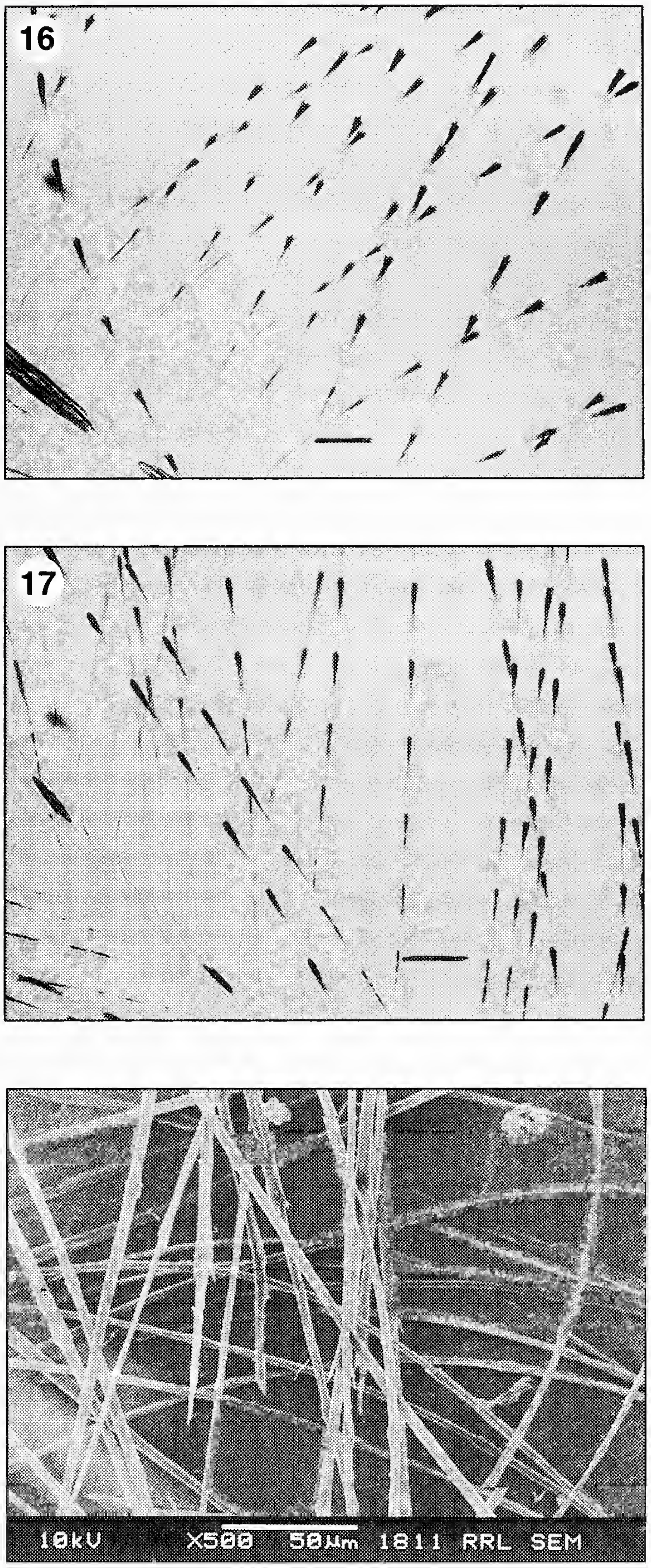
Rajaram, A.: Barbule structure PLATE 4



Figs 11-15: 11a. Indian white-backed vulture (SEM), 11b. Indian white-backed vulture (OMB), 12. Painted stork (SEM), 13. Spot-billed pelican (SEM), 14. Brahminy kite (OMB), 15. Greater coucal (OMB)

Rajaram, A.: Barbule structure

PLATE 5



Figs 16-18: 16. Eurasian eagle owl (OMB), 17. Spotted owlet (OMB), 18. Black kite (SEM)

printed representative pictures, it could cause some confusion. Fig. 2a is from a blue rock pigeon *Columba livia*. The fresh feather has a powdery coating, which may be the powder keratin said to be found in this species. The nodal projections are clearer when this powder keratin is cleaned (Fig. 2b). Fig. 2c shows the barbule under an optical microscope. The figure is similar to the one published by Rosalind and Grubh (op. cit.), but the pigmentation is invisible in this photograph as my focus point is different. Barbules from a Pompadour green-pigeon *Treron pompadora* (Fig. 3) resemble that of the blue rock pigeon. The barbules from a house crow *Corvus splendens* (Fig. 4) show pigmentation at the nodes. There is a distinct increase in thickness from node to node towards the distal end of the barbule, as seen in the SEM. Common myna *Acridotheres tristis* feathers show distinct pigmentation above and below the node (Fig. 5b). The Indian pitta *Pitta brachyura* feather has a node with a uniform projection all around (Fig. 6a) and the pigmentation is also distinct (Fig. 6b). The roseringed parakeet *Psittacula krameri* (Fig. 7) has nodal projections extending over a longer portion as seen in the SEM, a more helpful diagnostic feature than the OMB and the figure published earlier.

In case of white feathers, there was little contrast in the OMB. Hence the samples were observed in polarized light. The black-crowned night-heron barbules (Fig. 8) can be distinguished by the shorter internodal distance compared to that of the cattle egret *Bubulcus ibis* (Fig. 9) and median egret *Mesophoyx intermedia* (Fig. 10), but there is little difference between the last two. SEM (Fig. 8a) is not useful in identifying the black-crowned night-heron or the cattle and median egrets (not shown). White feathers are thus difficult to identify if the details are not present at the nodal junctions. The SEM seen in Fig. 8a is similar to many feathers like the Indian white-backed vulture *Gyps bengalensis* (Fig. 11a), the painted stork *Mycteria leucocephala* (Fig. 12) and the spot-billed pelican *Pelecanus philippensis* (Fig. 13). However, the OMB of the Indian white-backed vulture (Fig. 11 b) is distinctive in that there seem to be pores within the barbules. Does this help in reduced buoyancy in soaring flight? The nodal projections are comparatively less prominent in birds that soar, and may be an adaptation for smoother air flow. The barbule structure of the brahminy kite *Haliastur indus* (Fig. 14), greater coucal *Centropus sinensis* (Fig. 15), Eurasian eagle owl *Bubo bubo* (Fig. 16) and spotted owlet *Athene brama* (Fig. 17) are also shown. Greater coucal barbules show pigmentation throughout. The nodal projections are more prominent in the Eurasian eagle owl than in the spotted owlet, but some relatedness is also evident. However, when we compare the barbules of the spotted owlet with the published picture of the Eurasian scops-owl *Otus scops* (Rosalind and Grubh op. cit.), there is little difference.

From the various species studied here, only two of the eight observations mentioned in the earlier paper are really helpful in identification from the barbule structure alone. In addition to: "barbules are clearly subdivided into nodes and internodes, which are often pigmented" it can be said that the nodes have a distinct projection whose shape, size and orientation are largely characteristic of the species. Often, the thickness of the barbules is related to the size of the bird, even though there are exceptions (eg. black kite *Milvus migrans* (Fig. 18) has comparatively thinner barbules). The nodal projections are more prominent in passerines than in birds that soar. The variations in barbule structure are less significant in related birds (blue rock pigeon vs. Pompadour green-pigeon, spotted owlet vs. Eurasian scops-owl). More detailed studies are required for identifying closely related species and those with mostly white plumage.

Acknowledgements

I thank Dr. Peter Koshy and colleagues of Regional Research Laboratory, Thiruvananthapuram for some of the SEM pictures.

NEW DESCRIPTIONS

MELANOCHAETOMYIA, A NEW GENUS OF CHLOROPIDAE (DIPTERA) FROM THE ORIENTAL REGION[1]

P.T. Cherian[2]

(*With five text-figures*)

Key words: *Melanochaetomyia* gen. nov., *M. rubrohalterata* sp. nov., Chloropid fly, Oriental Region

Melanochaetomyia gen. nov. is described from India with *M. rubrohalterata* sp. nov., the type species.

Introduction

The close affinities of *Elachiptera* Macquart to its congeners *Melanochaeta* Bezzi, *Disciphus* Becker, *Anatrichus* Loew and others were recognized by earlier workers like Duda (1934), Cherian (1975) and Sabrosky (1977). Andersson (1977) brought them together under genus *Elachiptera*, which was followed by Kanmiya (1983). Nartshuk (1983, 1987) assigned the status of a tribe, namely Elachipterini Lioy, to this group after removing *Cadrema* Walker and adding four more genera to it. While studying this tribe, one new species was found, which possesses a combination of characters not found in any other genus of the tribe or any other Chloropid genera. A new generic name, *Melanochaetomyia* is proposed to describe this species.

The type specimen is deposited in the collections of the Southern Regional Station, Zoological Survey of India, Chennai. Regn. No. I/DC/122; SRS/ZSI.

Melanochaetomyia gen. nov.

Type species: *Melanochaetomyia rubrohalterata* sp. nov.

[1]Accepted November, 1999

[2]Zoological Survey of India, Southern Regional Station, 100, Santhome High Road, Chennai 600 028, Tamil Nadu, India.

Description: Black, stocky-bodied flies with polished frontal triangle bearing long hairs on each half, 10 *orb*, 1+2 *npl* and a bristle on katepisternum (sternopleuron).

Head higher than long; frons slightly widened at vertex otherwise parallel-sided, projecting above and beyond eyes anteriorly, with long dense punctate *fr*; frontal triangle large, polished, reaching four-fifths length of frons, with nearly pointed apex and punctate hairs on the triangle on either side. Face deeply concave, densely silvery grey tomentose; facial carina low, reaching almost middle of face; epistomal margin a little raised. Antenna erect; ant 2 with long slender spine; ant 3 reniform, 1.3x as wide as long; arista not terminal; flagellum slender with long, fairly dense hairs. Eye large with vertical long axis and very dense pubescence. Gena rather narrow, densely tomentose, as also postgena, the latter with long hairs; vibrissal corner nearly a right angle; vibrissa long and slender; occipital margin around bases of *ovt* and *ivt* tomentose and with dense hairs; a row of postocular setae well developed. Head bristles black with erect and convergent *oc*, well-developed vertical bristles, 9-10 *orb* and inclinate *if*.

Thorax predominantly brownish-black; scutum glabrous with two lateral and two median longitudinal stripes and white punctate hairs; humeral callus and the area behind up to base of wing, part of *anepst*, hypopleuron and margins of scutellum tomentose; scutellum nearly semicircular

with almost flattened disc and punctate hairs; thoracic bristles well developed with 1 *h*, 1+2 *npl*, *pa* 1, *pa* 2, 1 *dc*, widely separated *as* and *ss* 1 and a bristle on *kepst* as in species of *Cadrema.*

Wing with brownish tinge; m_{1+2} ending beyond apex of wing; r-m cross-vein beyond middle of discal cell; anal angle well developed. Haltere partly red and yellow.

Legs brownish-black, but for yellow tarsi; femoral organ a row of 7-8 short spines; tibial organ long, oval.

Abdomen black, somewhat shiny, densely silvery-grey tomentose with long erect hairs except for dorsal areas of basal segments. Male genitalia: Epandrium broader than long; surstylus broadly triangular, narrowly rounded apically; cercus moderately developed; hypandrium broadly and shallowly incised on outer margin of basal bridge; aedeagal apodeme well developed; distiphallus subcylindrical, progressively somewhat narrowing distally; postgonite unlike in *Melanochaeta* not triangular but subcylindrical, ending with a somewhat obtuse apex.

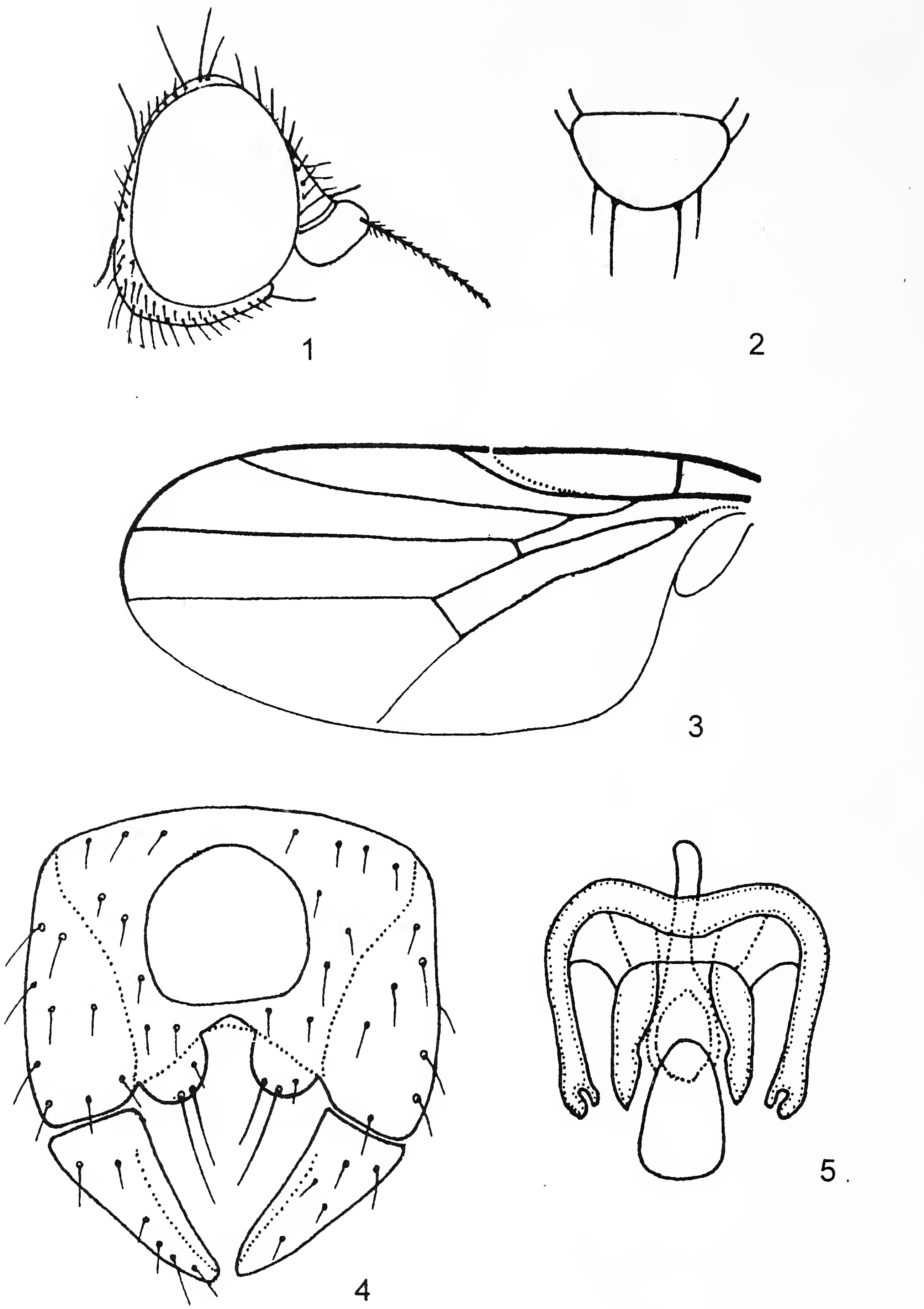
Gender and derivation: Feminine; from *Melanochaeta* plus the suffix myia.

One species, *rubrohalterata* is described here which is the type species.

Melanochaetomyia rubrohalterata sp. nov.
(Figs 1-5)

Male: Head (Fig. 1): Much higher than long, length, height and width ratio 2:3:4. Frons greatly depressed, but anteriorly area beyond lunule projecting prominently above eyes, parallel-sided but slightly widened at vertex, where it is silvery grey tomentose and with prominent hairs, width 0.85x the length and 0.43x the width of head, blackish-brown, but projecting area anteriorly brownish-yellow, wholly with prominent whitish-black *fr*; frontal triangle large, shiny brownish-black, reaching four-fifths the length of frons, ending with narrowly obtuse apex, with a few prominent punctate hairs on triangle mostly confined to either side of median part and the area behind, area inner to lateral margin with 2 to 3 very low, linear short ridges and depressions, each commencing from vertex margin and extending to level of posterior margin of anterior ocellus. Face deeply concave, much narrower than frons, brownish-black, very densely silvery grey tomentose and hence appearing grey; facial carina very low, triangular between eyes and extending hardly one-fourth the length of face and roofed basally by projecting frons; spine on ant 2 long; ant 3 reniform, 1.5x as wide as long, upper one-third brownish-black, rest yellow; arista black, basal segments slightly thickened and with short hairs, flagellum slender with dense prominent concolorous hairs. Gena dark brown, one-fifth as wide as ant 3, grey plumose; vibrissal corner almost a right angle with long, slender vibrissa; postgena concolorous with and plumose like gena. Palpi yellowish-brown; proboscis partly shiny black and partly brown. Head bristles well developed, black; *ovt* and the cruciate *pvt* subequal; *ivt* a trifle shorter than *ovt*; *oc* upright, convergent, three-fifths the *pvt*; *orb* about 10, posterior 4 more developed and reclinate to partly erect, the rest slanting and inclinate; *if* in a row outside the triangle along lateral margin and a few on the triangle on either side not in rows; *if* and the well developed *fr* almost of equal size; a well developed row of long black postocular setae very prominent.

Thorax: Almost as wide as head, predominantly brownish-black, scutum 1.15x as long as wide with glabrous, greatly convex disc bearing two median and two lateral longitudinal dark blue stripes, of which each of former commences from the anterior margin and extends to three-fifths the length, while both more broad lateral ones extend from level of humeral callus and taper off above 1 *dc* at the level of *pa* 2, wholly covered with dense white finely punctate hairs which are somewhat parted along narrowly grooved *acr* and *dc* lines; humeral callus and area



Figs 1-5: *Melanochaetomyia rubrohalterata* sp. nov., 1. Head, 2. Scutellum, 3. Wing, 4. Epandrium, 5. Hypandrium and Phallic complex

up to base of *pa* 1 densely silvery grey tomentose; scutellum (Fig. 2) nearly semicircular, 1.2x as wide as long, with nearly flattened glabrous disc and thick, densely tomentose margins, concolorous with and punctate and pubescent like scutum; pleura brownish-black with glabrous black maculae along lower anterior margin of *anepst*, lower margin of meron above coxa on *anepm*, except for part of lower halves densely tomentose; *kepst* with long white hairs and one bristle. All thoracic bristles black, well developed; *h* 1; *npl* 1+2 and 1 dc all subequal; *pa* 1 a trifle longer than *pa* 2 and shorter than 1 *dc*; *as* as long as scutellum, widely separated; *ss* 1, 0.6x the *as*.

Wing (Fig. 3): Brownish, as long as body and 2.42x as long as wide, distinctly brownish; m_{1+2} ending beyond wing apex; proportions of costal sectors 2 to 4 in the ratio 25:15:8; r-m cross-vein beyond middle of discal cell at 0.57 of its length; terminal sectors of r_{4+5} and m_{1+2} parallel; anal angle well developed. Distal half of knob of haltere reddish, basal part and stalk yellow.

Legs: With dense yellow hairs; coxae, trochanters, femora and tibiae brownish-black; femoral organ well developed, distinctly projecting in the form of one row of 8 to 9 warts; tibial organ long, oval; all tarsi yellow; midtibia with a slender terminal spine.

Abdomen: Somewhat shiny black, whole of dorsum grey tomentose, covered with long dense black hairs except for the median parts of basal segments.

Male genitalia (Figs 4, 5): epandrium much wider than long; cercus with two long hairs; surstylus well developed, with conspicuous hairs; postgonites with a few short hairs distally.

Length: Male 2.8 mm; wing 2.7 mm.

Holotype: Male, INDIA: Meghalaya: Nangpo, 10.iv.1979, Coll. P.T. Cherian.

Remarks: This species was collected along with other members of the Tribe Elachipterini belonging to genera *Melanochaeta* Bezzi, *Elachiptera* Macquart and *Cadrema* Walker from the Nango forest in Meghalaya, a haven for diverse groups of insects, especially dipterans. It differs from all its congeners, apart from other characters, in possessing well-developed hairs on the frontal triangle.

Abbreviations: *acr* acrostical; *anepm* anepimeron; *anepst* anepisternum; *as* apical scutellar bristle; *dc* dorsocentral bristle; *fr* frontal hairs; *h* humeral bristle; *if* interfrontal bristle; *ivt* inner vertical bristle; *kepst* katepisternum; *npl* notopleural bristle; *oc* ocellar bristle; *orb* fronto-orbital bristle; *ovt* outer vertical bristle; *pa* postalar bristle; *pvt* postvertical bristle; *as* subapical scutellar bristle.

ACKNOWLEDGEMENT

I am grateful to the Director, Zoological Survey of India, Kolkata for encouragement.

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TWO NEW SPECIES OF GENUS *COLLOTHECA* HARRING 1913 (ROTIFERA: MONOGONONTA) FROM FRESHWATERS OF TRIPURA, INDIA[1]

S. Banik[2]

(*With two text-figures*)

Key words: *C. tetralobata* sp. nov., *C. hexalobata* sp. nov., new species, freshwater wetland

The present study recorded two new species: *Collotheca tetralobata* sp. nov. and *C. hexalobata* sp. nov. from the wetlands of Tripura which are described here. In order to find out their ecological niche characteristics, different physicochemical factors of water, preference of plant-substrata, and seasonal occurrence of the species were also noted.

Introduction

Collotheca belongs to the sessile fauna under Phylum Rotifera. In India, some workers (Anderson 1889, Sarma and Rao 1986, Sarma 1988, Banik and Kar 1995) studied the taxonomy of the genus. However, Koste (1978) made a detailed study on their taxonomy with regard to the European region. In taxonomic observations, knowledge of ecological conditions is most helpful to get an idea of the distribution of species, which is lacking in most descriptions of new taxa (Anderson 1889, Segers *et al.* 1994).

The present work describes two new rotifer species with their ecological characteristics such as physicochemical conditions of their freshwater habitat, nature of plant substrata and seasonal occurrence.

Material and Methods

The rotifer fauna were collected live from natural substrata (such as root, stem and leaf of hydrophytes) from the littoral region of shallow water wetlands of Agartala, Tripura (23° 50' 15" N and 91° 15' 45" E) during 1994-1997. The live specimens were examined under an Olympus Trinocular-KH microscope with a camera lucida. Preparation of trophi was done following the method of Banik and Kar (1995) and Banik (1996). The physicochemical analysis of freshwater was made following APHA (1992).

Type specimens were deposited in the Fishery Laboratory, University of Calcutta, Kolkata (MFLC) and in the collection of the Fishery & Limnology Research Unit, Tripura University, Tripura (RTU). All measurements (size of body, amictic and resting eggs of the rotifer fauna) are expressed in µm. Koste's (1978) key was followed for the description of the taxa.

Results

Family: Collothecidae
Genus: *Collotheca* Harring 1913
Collotheca tetralobata sp. nov.
Collotheca hexalobata sp. nov.

Collotheca tetralobata sp. nov.

Materials examined: Twelve parthenogenetic females (Holotype, MFLC 219); nine parthenogenetic females (Paratype, MFLC 220); a glass vial with 23 specimens (Paratype, MFLC 221). One parthenogenetic female, one mictic female (Paratype, RTU); six parthenogenetic females (Paratype, RTU); permanent mounted slide consists of entire animal and trophi (RTU).

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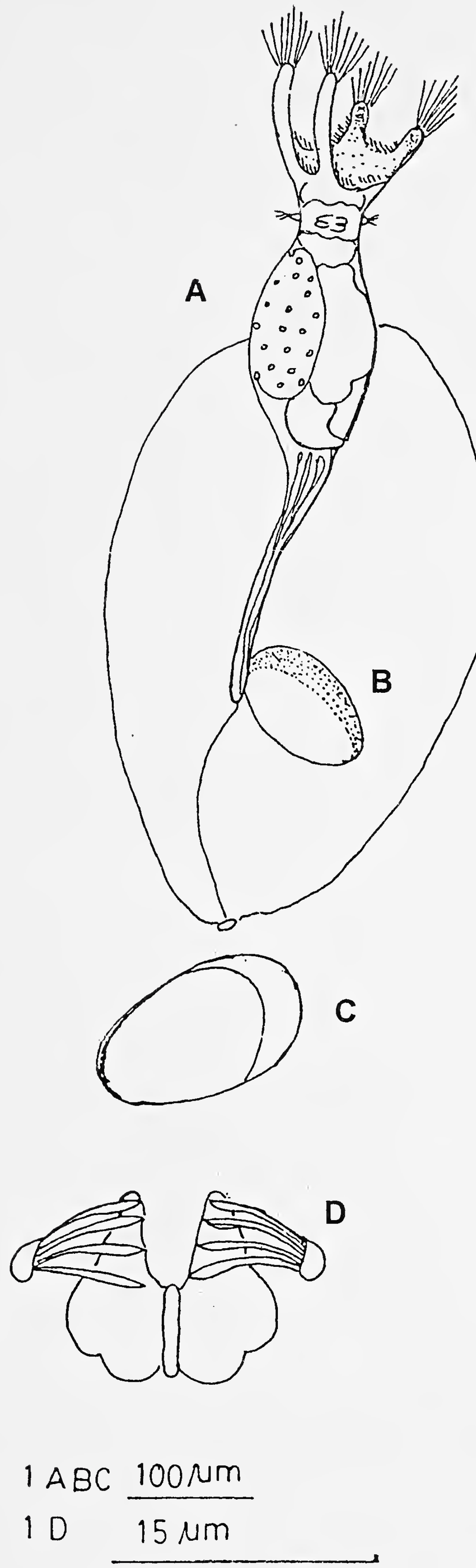

Fig. 1: *Collotheca tetralobata* sp. nov., A. The specimen in normal condition, B. Amictic egg, C. Resting egg, D. Trophi

Description: Parthenogenetic Females (Figs 1A-D). Corona with four unequal, blunt lobes (two longer) and tetragonally arranged. Bristles longer at the tip of the lobes. Cilia very small at interlobal area. Germovitellarium distinct during pre-reproductive period. Lorica transparent, very long, oval-shaped. Holdfast much longer. Longitudinal and circular muscles of coronal lobes distinct during relaxation. Antennae paired, laterally placed between coronal funnel and the trunk. Amictic eggs, 3-5 at a time. Resting eggs, 1-2 at a time. Just before laying eggs, the animal undergoes a resting condition for a few seconds. Trophi uncinate type (Fig. 1D), uncus and subuncus distinct. Males unknown.

Measurements in µm:

Total length of the body	700-770
Length of the lorica	400-467
Length of longer tube	97-106
Length of shorter tube	63-69
Breadth of corona	57-65
Length of the trunk	216-221
Breadth of trunk at apex	43-49
Breadth of trunk at base	15-19
Length of the foot	220-248
Length of the holdfast	167-195
Length of amictic egg	100-116
Width of amictic egg	71- 89
Length of resting egg	173-184
Width of resting egg	102-112

Differential diagnosis: The new species belongs to the *C. ornata* type, but is easily distinguished from *C. ornata* by the presence of two longer lobes and two shorter lobes, paired lateral antennae, very long holdfast and interlobal cilia, and by the absence of pentagonal arrangement of five short lobes and very reduced holdfast.

Collotheca tetralobata sp. nov. might also be confused with the congener possessing blunt lobes. *C. ornata*, however, has odd numbered smaller lobes of similar size and varied shape of lorica.

Ecological Characteristics

a) *Physicochemical conditions of water*: The new species was found in temperatures of 10-21 °C, dissolved oxygen 4.7-8.9 ppm, pH 6-6.9, bicarbonate 63-98 ppm, silicate 3-9 ppm and dissolved organic matter 3-7.6 ppm.

b) *Plant-substrata preference*: This species occurs on stems and leaves of *Utricularia vulgaris*. Sometimes occurred on root-hairs of *Eichhornia crassipes* also. However, it was not seen in any other macrophytes.

c) *Seasonal Occurrence*: *Collotheca tetralobata* sp. nov. was noted in the winter months only.

Collotheca hexalobata sp. nov.

Material examined: Nine parthenogenetic females (Holotype, MFLC 323); eleven parthenogenetic females (Paratype, MFLC 324), vial with 30 specimens (Paratype, MFLC 325). One parthenogenetic female, one mictic female (Paratype, RTU), five parthenogenetic females (Paratype, RTU), permanent mounted slide with entire animal and trophi (RTU).

Description: Parthenogenetic females (Figs 2A-D). Corona broad with six equal, blunt lobes arranged hexagonally. Bristles longer, germovitellarium distinct during adult period. Lorica less transparent, wavy at the lower part. Holdfast much longer, with continuous contraction habit. Base of holdfast broad, oval. Antennae paired, lateral. Amictic eggs, 2-3 at a time. Resting eggs, 2-3 time. Trophi uncinate type (Fig 2D). Males unknown, probably distorted during mounting process.

Measurements in μm:

Total length of the body	1,426-1,530
Length of the lorica	300-398
Length of the lobe	65-79
Breadth of the corona	271-280
Length of the trunk	383- 400
Breadth of trunk at apex	97-101
Breadth of trunk at base	59-65

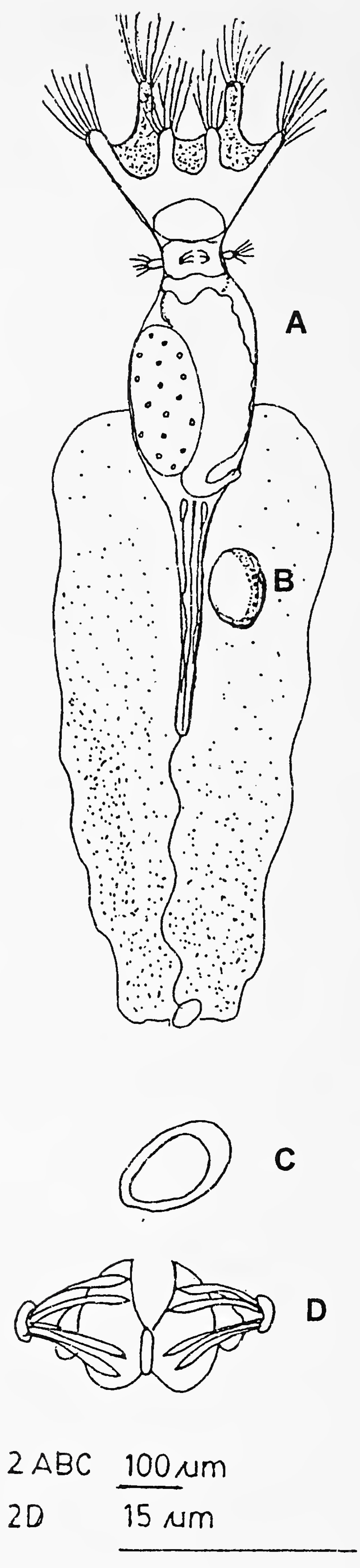

Fig. 2: *Collotheca hexalobata* sp. nov., A. The specimen in normal condition, B. Amictic egg, C. Resting egg, D. Trophi

Length of the foot	357-381
Length of the holdfast	477-510
Length of amictic egg	107-118
Width of amictic egg	73-88
Length of resting egg	168-180
Width of resting egg	100-113

Differential diagnosis: The new species belongs to the *C. tenuilobata* type, but is easily distinguished from *C. tenuilobata* by the presence of six lobes, longer holdfast and its broad and oval base and by the absence of pentagonal arrangement of tubular lobes, interlobal cilia, greatly reduced holdfast with small and round base and a transparent lorica.

C. hexalobata sp. nov. might also be confused with the congener whose tubular lobes look like blunt lobes and the longer holdfast seems to be a reduced one under contracted condition of the whole body, which is an important behavioural character of *C. tenuilobata.* However, *C. tenuilobata* under relaxed condition shows a transparent lorica, pentagonal lobes and much reduced holdfast.

Ecological Characteristics: a) *Physico-chemical conditions of water*: *C. hexalobata* sp. nov. was found at temperatures of 16-34 °C, dissolved oxygen 3.6-7.8 ppm, pH 5.7-6.8, bicarbonate 34-89 ppm and dissolved organic matter 6-13 ppm.

b) *Plant-substrata preference*: This species was found only on root-hairs of *Eichhornia crassipes*.

c) *Seasonal Occurrence*: It was observed mostly during summer, and only one individual was noted in winter (i.e. in December 1994 and November 1996).

Discussion

The morphological characteristics of the two new species *C. tetralobata* sp. nov. and *C. hexalobata* sp. nov. do not exhibit any specific similarity with known rotifer species of *Collotheca* Harring 1913 (Koste 1978). *C. tetralobata* sp. nov. can be confused with *C. ornate* and *C. hexalobata* sp. nov. with *C. temalobata* to some extent. However, the new taxa are quite different from the known rotifer species because of some distinct, new and easily identifiable taxonomic characters (Segers *et al.* 1992, 1994).

Besides this, the most interesting feature of the new taxa is species-specific ecological niche characteristics such as physicochemical condition of water, preference of particular plant-substratum for growth, food and occurrence of species in particular season(s) (Banik 1987, Datta and Banik 1987, Banik and Kar 1995, Banik 1996, 1997, 1998, 1999).

The present observation confirms that shallow freshwater bodies of Tripura are much neglected in studies of sessile rotifers (Banik *et al.* 1994)

Acknowledgements

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■ ■ ■

A NEW CYPRINID FISH SPECIES OF *BARILIUS* HAMILTON FROM THE CHATRICKONG RIVER, MANIPUR, INDIA[1]

KEISHING SELIM AND WAIKHOM VISHWANATH[2]

(*With one text-figure*)

Key words: New species, *Barilius chatricensis* sp. nov., Manipur

A new species of *Barilius* is described based on ten specimens from Chatrickong river, flowing through Chatrick village of the Ukhrul district, Manipur, India. The species is characterised by 15 rows of scales in front of the dorsal fin, 7-8 distinct dark blue bands on the side of the body, absence of a dark spot at the base of the caudal fin, and absence of barbels on the snout. The maxilla does not reach the base of the pectoral fin. The dorsal fins do not commence midway between the eye and base of caudal fin, and the last short dorsal fin-ray does not reach the caudal peduncle. Lateral line is complete with 38 scales, and predorsal scales are 15 in number.

INTRODUCTION

The bariline fishes of the genus *Barilius* Hamilton (Family Cyprinidae: Cyprininae) inhabit medium to fast torrential mountain streams of the Indian subcontinent, Thailand and Myanmar. The fishes are characterised by a compressed body, blue-black transverse bars or spots on the body and dorsal fins inserted beyond the middle of the body (Hamilton 1822). Howes (1980) made detailed study on the systematics of the genus, based on anatomical and osteological characters. The genus, as now restricted, includes only those species occurring in India, Nepal, Bangladesh, Sri Lanka, Myanmar and Thailand, with 25 species of the genus *Barilius*, 15 being in the Indian region (Talwar and Jhingran 1991). Only three species of *Barilius* were hitherto known from Manipur, India, namely *B. barila* (Hamilton 1822), *B. bendelisis* (Hamilton 1822) and *B. dogarsinghi* Hora 1921. A new species of *Barilius* is described here from Chatrickong river, that flows in the Ukhrul district of Manipur, India. The river is formed by two important tributaries: Khunukong and Sanalok; both of which meet at Dha-ado and flow as Chatrickong for about 5 km on Indian soil and then into Myanmar, finally meeting the Chindwin near Homalin, a township in Myanmar (about 24° 40' N, 94° 45' E).

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MATERIAL AND METHODS

The new species was collected by cast net. Type specimens are deposited in the Manipur University Museum of Fishes (MUMF). Standard measurements and counts were made following Jayaram (1981). Body proportions are expressed as percentage of standard length (SL) and head length (HL). Transverse scales were counted as scaled between lateral line and dorsal fin origin and from lateral line to pelvic fin origin.

Barilius chatricensis sp. nov.

Holotype: MUMF 530/1, 86.4 mm (SL), Chatrickong river, Ukhrul District, Manipur, India. 150 km from Imphal. Coll. Keishing Selim; 16.xi.1995.

Paratype: MUMF 531/9 58.6-89.00 mm (SL). Data same as Holotype.

Diagnosis: A species of *Barilius* with 7-8 thick blue-black transverse bands on the body which do not extend to lateral line; lateral line scales 38; predorsal scales 15. Maxilla does not reach the base of pectoral fin. Dorsal fins do not commence midway between the eye and base of caudal fin. Barbels absent on snout and no dark spots at the base of caudal fin.

Description: D. II, 7; P. i, 11; V. i, 8; A. ii, 10; C. 18; L.1. 38; L.tr 7/1/2; PDS. 15. Proportional measurements and counts of the fish are shown in Table 1. Body compressed, abdomen rounded, snout blunt, cleft of jaws with numerous pores. Upper jaw longer than lower. Eyes large, situated in the anterior half of the head. Barbels absent on snout. Maxilla does not reach the base of pectoral fin, and dorsal fins do not commence midway between eye and base of caudal fin. Dorsal profile in front of the dorsal fin relatively straight, slightly curved towards the base of the caudal fin. Dorsal fin inserted beyond middle of standard length; its insertion reaches the base of pelvic fin and its last fin ray short, not reaching caudal peduncle. Ventral fin does not reach anal fin. Vent opens just above base of anal fin. Caudal fin deeply forked, lower lobes longer than upper lobes.

Colour: Body silvery white, slightly dark dorsally. 7-8 dark blue bands on the sides of the body. Bands short, thick, tapering towards the lateral line but not extending to it. Pectoral, ventral and anal fins tinged with orange colour in fresh condition.

Distribution: Chatrickong river, Ukhrul district, Manipur, India.

Etymology: The species name refers to the Chatrickong river from where the type material was collected.

Remarks: *Barilius chatricensis* sp. nov. is similar to *B. dogarsinghi* Hora in some of its body proportions. But it differs from the latter in

TABLE 1
MORPHOMETRIC CHARACTERS

Characters	Holotype	Paratypes N=10	Mean
In % of standard length:			
Body depth	28.00	24.57-29.21	26.89
Head length	25.23	25.23-27.07	26.15
Caudal length	24.07	24.07-28.27	26.15
Predorsal length	53.33	51.43-55.46	53.43
Dorsal fin height	18.23	17.51-20.85	19.18
Pectoral fin length	20.13	18.31-21.84	20.07
Pelvic fin length	15.50	15.50-18.25	16.87
Anal fin height	15.39	14.34-18.65	16.49
In % of head length:			
Head width	50.45	46.47-52.90	49.68
Head height at occiput	75.22	73.82-82.22	78.02
Snout length	30.73	29.82-34.85	32.33
Interorbital space	50.91	45.34-53.10	49.22
Eye diameter	28.89	25.72-29.82	27.77
Caudal peduncle length	71.55	71.78-79.79	75.78
Caudal peduncle depth	38.99	38.01-43.60	40.80
Mouth width	33.02	30.81-38.22	34.51
In % Caudal peduncle length:			
Caudal peduncle depth	54.44	48.76-57.00	52.88
Counts			
D rays	II, 7	II, 7	
P rays	i, 11	i, 11	
V rays	i, 8	i, 8	
A rays	ii, 10	ii, 10	
L.l.	38	38	
L.tr.	7/1/2	7/1/2	
Predorsal scales	15	15	
Circumpeduncular scales	14	14	
Transverse bands on body	7	7-8	

L.l. = Lateral line longitudinal scales
L.tr. = Lateral transverse scales

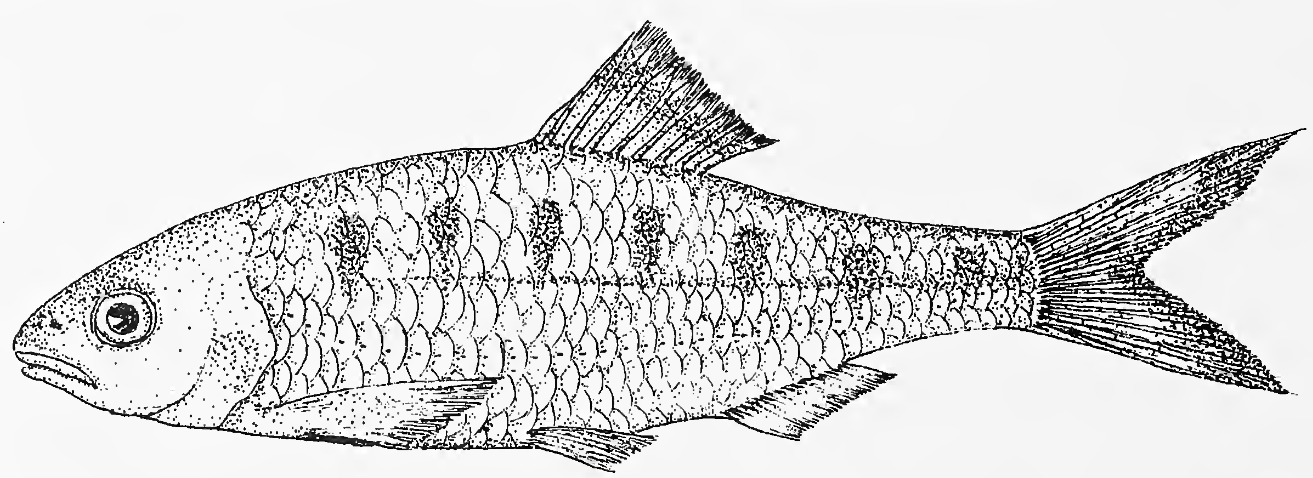

Fig. 1: *Barilius chatricensis* sp. nov., MUMF 530/1, 86.4 mm (SL)

TABLE 2
COMPARISON OF *B. CHATRICENSIS* SP. NOV. WITH OTHER BARILINES

Characters	*B. chatricensis* sp. nov.	*B. dogarsinghi* Hora	*B. dogarsinghi* Hora	*B. bendelisis* (Ham.)	*B. barna* (Ham.)	*B. barila* (Ham.)
	n = 10	ZSI/F 2208/2 n = 3	MUMF 360/ n = 10	ZSI 4233	ZSI / 12042 / 12038	MUMF 545 / n = 6
In % of Standard Length						
Body depth	24.57-29.21	21.69-23.49	24.07-26.91	22.79-24.14	23.37-23.39	23.46-26.12
Head length	25.23-27.07	22.84-23.85	22.44-23.97	23.33-25.95	20.83-21.63	24.66-25.78
Predorsal length	51.41-55.46	61.42-66.41	58.95-62.72	56.65-57.63	55.55-55.59	55.40-59.64
Head height at occiput	73.82-82.22	78.40-82.78	85.00-86.70	73.91-79.18	75.50-78.30	72.06-78.60
Eye diameter	25.72-29.82	24.60-28.64	22.22-25.60	22.49-22.60	25.55-25.80	30.84-33.72
Caudal peduncle length	71.78-79.79	83.33-85.24	81.81-85.45	-	80.55-80.64	-
Caudal peduncle height	38.01-43.60	45.90-52.80	46.06-47.27	-	43.54-50.55	-
Mouth width	30.81-38.22	21.60-25.40	26.06-28.88	-	28.05-29.00	-
Predorsal scales	15	20	20	19	16	20
Barbels	Nil	2 pairs	2 pairs	2 pairs	Nil	2 pairs
Miscellaneous Characters						
Black dots on caudal base	no black dots	a large black dot present	a large black dot present	a black spot present	no black dots	no black dots
Transverse bands on body	7-8 dark blue bands	8-9 dark blue bands	8-9 dark blue bands	8-12 dark blue bands	9-11 dark blue bands	13-14 dark blue bands
Extension of ventral fin	does not reach anal fin origin	reaches anal fin origin	reaches anal fin origin	does not reach the anal fin	does not reach the anal fin	does not reach the anal fin
Extension of pectoral fin	reaches ventral fin origin	does not reach ventral fin origin	does not reach ventral fin origin	reaches the ventral fin origin	does not reach ventral fin origin	does not reach ventral fin origin
Characteristics of transverse bands	bands shorts, thick, tapers towards belly, do not reach lateral line	bands narrower, more or less of uniform thickness, reach lateral line	bands narrower, more or less of uniform thickness, reach lateral line	bands narrower, descending towards the lateral line	bands narrower, more or less uniform thickness, reach lateral line	bands narrower, more or less uniform thickness, reach lateral line

having a longer head, shorter predorsal length, shorter and shallower caudal peduncle, wider mouth, fewer predorsal scales and absence of barbels on the snout. The new species is also distinct from *B. dogarsinghi* in colour pattern and extension of fins (See Table 2).

It also differs from *B. barna* (Ham.) in that the maxilla does not reach the base of pectoral fin and the last dorsal fin ray, being short, does not reach the caudal peduncle. Dorsal fin commences midway between the eye and base of caudal fin in *B. barna*, whereas it does not commence midway between eye and base of caudal fin in *B. chatricensis*. Lateral line complete with 39-42 scales, predorsal scales 16 in *B. barna*, whereas in *B. chatricensis* the lateral line is complete with 38 scales and predorsal scale 15. *B. barna* has 7-11 well defined vertical dark bars and flanks with 7-9 narrow deep blue vertical bands, whereas in *B. chatricensis* there are only 7-8 distinct dark blue bands.

The new species also differs from *B. bendelisis* (Ham.) in lateral line scales numbering 40-45; predorsal scales are 18-20; 2 pairs of barbels; 8-12 dark bands and poorly developed tubercles.

Barilius guttatus Day and *B. bola* (Hamilton) were reported by Menon (1952) and Menon (1954) respectively, from Manipur. These species are, however, included in the genus *Raiamas* Jordan by Howes (1980) in view of their greatly expanded kinethmoid, and low and shallow jaws. They are easily separated from other barilines of the region by their long gape, extending behind the orbit. Although, Howes (op cit.) did not examine *B. dogarsinghi*, it appears that this species along with the species under description belong to the second subgroup of the genus *Barilius*, exemplified by *B. gatensis* in which the body is deep, jaws short, barbels a single pair or absent, and tubercles large, and well developed tubercles.

Comparative Material: *Barilius dogarsinghi* Hora: ZSI (Zoological Survey of India) / F-2208/2, 3 specimens, from Manipur (No date or collector's name)

Barilius dogarsinghi Hora, MUMF – 360, 10 specimens from Chakpi stream, Manipur, coll. W. Vishwanath and Manoj (No date).

Barilius barna (Ham.) ZSI/12038, ZSI/ 12042, 2 specimen from Banor R. Deoli Ajmere, Mewara, coll. Biddulph & Museum collectors (No date).

Barilius bendelisis (Ham.) ZSI/ 4233, 2 specimens from Barak Kangjup, Manipur, coll. A.G.K. Menon on 1.ii.1953.

Acknowledgements

We thank the Director, Zoological Survey of India, Kolkata for permission to examine the type specimen of *Barilius dogarsinghi* Hora and *Barilius barna* (Ham.). We also thank the Ministry of Environment and Forests, Government of India, for financial assistance.

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A NEW SPECIES OF *EXACUM* L., GENTIANACEAE, FROM AGASTHIYAMALAI (POTHIGAI), SOUTHERN WESTERN GHATS, INDIA[1]

R. Gopalan[2]

(*With one text-figure*)

Key words: *Exacum klackenbergii* sp. nov., Agasthiyamalai, South Western Ghats

A new species of *Exacum*, from Agasthiyamalai (Pothigai), southern Western Ghats, India, is described and illustrated.

Exacum klackenbergi sp. nov.

A *Exacum wightianum* Arn. caulibus lignosis, teretibus (non alatis); foliis distincte petiolatis, ellipticis, apice enciforme acuminatis; antheris oblongis, ad basim sagittatis differt.

Holotypus (*R. Gopalan* 88726, CAL) and isotypi (*R. Gopalan* 88726, MH — num. acc. 163946-48) in Sangumuthirai, Pothigaimalai (Agasthiyamalai) in ditione Tirunelveli in statu Tamil Nadensi, India, ad altitudinum *c.* 1,500 m, die 5.ii.1989 lecti.

Allied to *E. wightianum* Arn. but differs in the stem being woody, terete (not winged), leaves distinctly petioled, elliptic, ensiformly acuminate at apex and anthers oblong, sagittate at base.

Herb, to 70 cm high, divaricately or erecto-patently branched; internodes varying in length, shorter than leaves; stems woody, terete at base, minutely striate towards apex; branchlets 4-angled. Leaves opposite, simple; petioles to 1.2 cm long, rounded abaxially, canaliculate abaxially (not amplexicaul); lamina elliptic, 2-6.5 x 0.9-2.1 cm, attenuate at base, entire and revolute along margins, acuminate or ensiformly acuminate (acumen to 15 mm long) at apex, coriaceous, 3-nerved at base; midrib prominent beneath, minutely grooved above; lateral nerves 2, prominent beneath, slightly raised above. Floral leaves 2; petioles to 4 mm long; lamina elliptic, 4-25 x 1-11 mm, attenuate at base, entire and revolute along margins, acuminate (acumen to 5 mm long) at apex. Inflorescence a terminal cyme (rarely solitary, axillary); peduncles and pedicels 4-angled, drooping, minutely winged; bracts 2, ovate, 3-5 x 0.7-2 mm, cuneate to attenuate at base, entire, acuminate at apex. Flowers zygomorphic, bisexual. Calyx 5-lobed; lobes coalescent to 3 mm from base, ovate-lanceolate, 13-15 x 4-5.5 mm, subequal, gradually narrowing towards apex, winged; wings (semi) cordate at base, distinctly nerved. Corolla blue, yellow at throat; tube 6-8 mm long; lobes 5, quincuncialis, broadly elliptic, 18-31 x 8-19 mm, membranous, wavy along margins, acute at apex. Stamens 5, adnate to corolla tube; filaments 2-3 mm long, flat; anthers oblong (not bottle-shaped), 8-9 x 1.5-2 mm, sagittate at base, opening by longitudinal slit above, with a prominent papilla near the apex on dorsal side, basifixed. Ovary oblong-ovoid, *c.* 7 x 4 mm; style stout, terete, 12-13 (-14) mm long, curved; stigma slightly capitate, viscid.

Holotype (*R. Gopalan* 88726, CAL) and isotypes (*R. Gopalan* 88726, MH – Acc. No. 163946-48) were collected from Sangumuthirai, Pothigaimalai (Agasthyamalai) in Tirunelveli district, Tamil Nadu, 1,500 m, 5.ii.1989.

Etymology: The species is named in honour of Dr. Jens Klackenberg, Botanical Institute, University of Stockholm, Sweden, for his valuable monograph on the paleotropical genus *Exacum* L. (Gentianaceae).

[1]Accepted April, 2000

[2]Botanical Survey of India,
Coimbatore 641 003, Tamil Nadu, India.

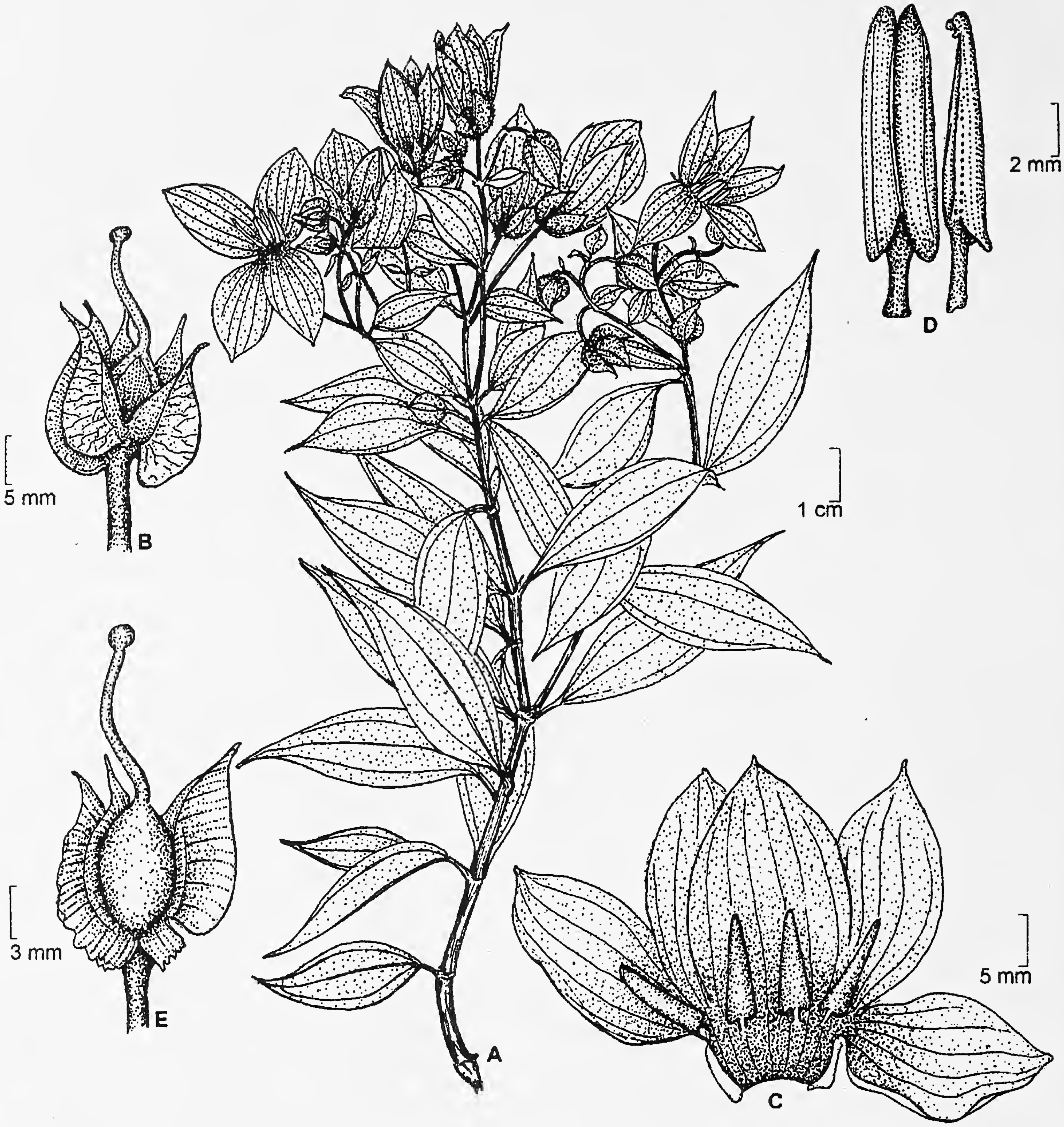

Fig. 1: *Exacum klackenbergi* sp. nov., A. Branchlet, B. Calyx, C. Corolla spreadout with stamens, D. Stamen (Front & Lateral views), E. Pistil

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■ ■ ■

THREE NEW SPECIES FROM THE SPIDER FAMILIES AMAUROBIIDAE, THOMISIDAE AND SALTICIDAE (ARANEAE: ARACHNIDA) FROM INDIA[1]

D.B. Bastawade[2]

(*With twenty-eight text-figures*)

Key words: Araneae, Amaurobiidae, new record, Indian main land, Families, Thomisidae, Salticidae, new species, *Amaurobius indicus*, *Camericus bipunctatus*, *Myrmarachne dirangicus*

Three new species of spiders have been described with first report of the Family Amaurobiidae from the Indian main land from the Maharashtra State as *Amaurobius indicus*. Additional two new species *Camericus bipunctatus*, *Myrmarachne dirangicus*, have been described under the families Thomisidae and Salticidae respectively and reported from Arunachal Pradesh, India. The detail descriptions and diagnostic illustrations have been provided for easy identification with key characters and allied species respectively.

Studies on the spider fauna of British India has been dealt with by many European Arachnologists namely Thorell, Simon, Stoliczka, Cambridge to Pocock and later by many Indians such as Narayana, Basu and more recently by Tikader, Sadana, Patel, Malhotra, Gajbe, Bal, Biswas and Reddy among others. Considering the wide variety of habits inhabited by spiders the present information seems scanty and scarce, and needs more study to understand the diversity amongst spiders.

This paper is based on recent survey explorations made for collections in various parts of India. The Family Amaurobiidae is being reported for the first time from the mainland. Tikader (1977) reported it earlier from the Andaman Islands. The Thomisid genus *Camericus* has so far been known from only two species (Tikader 1980). A third species is recorded here with its full description and illustrations. The Salticid genus *Myrmarachne* is being reported for the first time from Arunachal Pradesh by a new species.

[1]Accepted February, 2000

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Akurdi, Pune 411 044, Maharashtra, India.

Family: Amaurobiidae

Amaurobius indicus sp. nov.

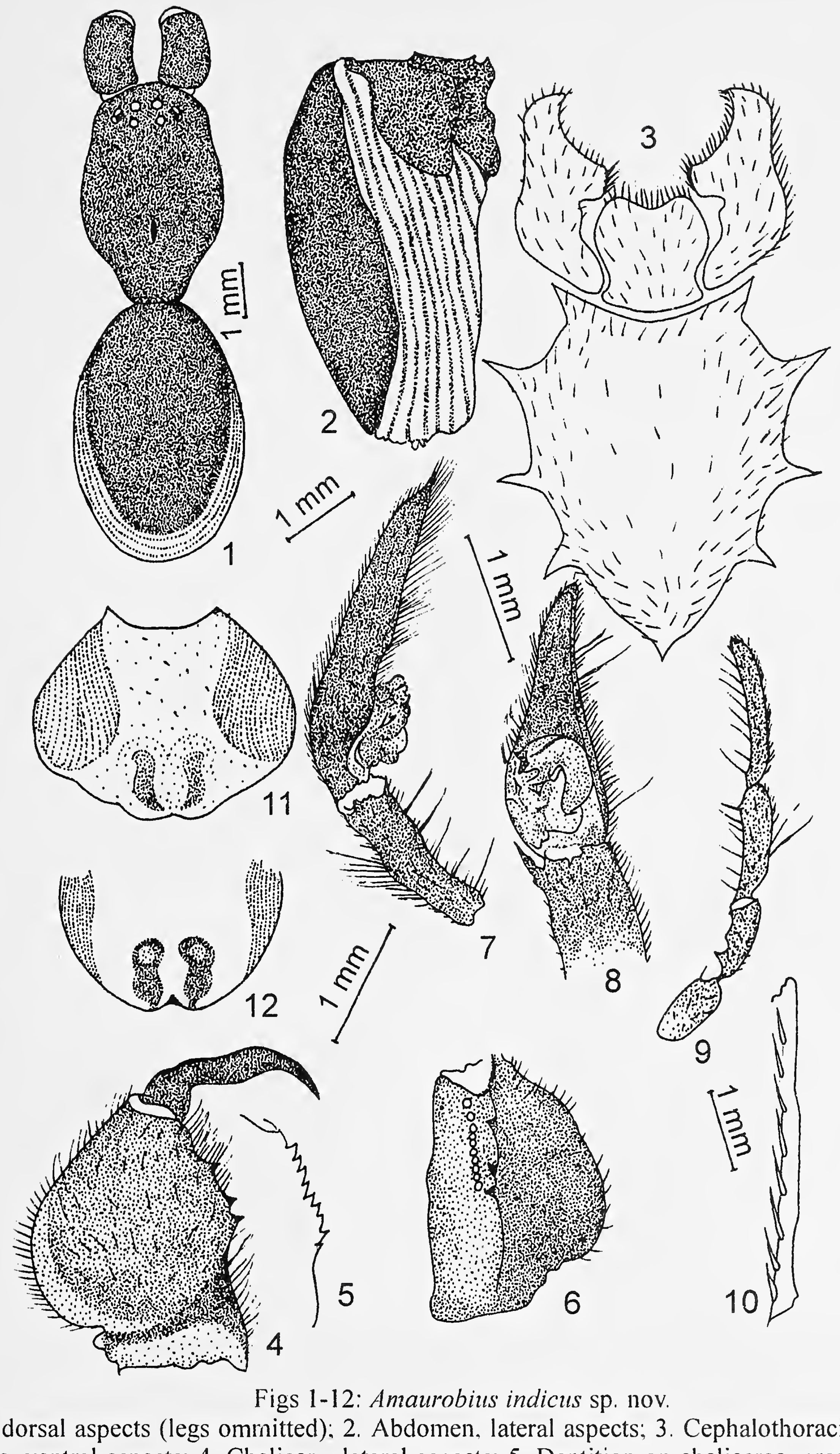
(Figs 1-12)

General: Dark blackish-brown to yellowish-brown in colour, ventral portion lighter; dorsum entirely covered with scutum in both male and female (Fig. 1) but the ventral collar extends posteriorly up to $2/3^{rd}$ portion.

All legs armed below with a row of paired spines on Tibiae and Metatarsi. Male with much elongated and shallow cymbium, and bulging paracymbium at the base.

Measurements (in mm): Total length 8.00; Cephalothorax 3.8 long, 2.3 wide; Abdomen 4.2 long, 3.8 wide.

Cephalothorax: Longer than wide, entire surface rough with fine granulation and without hair, median anterior portion high with high clypeus, eight eyes placed in two rows, laterals smaller and close to each other, anterior medians larger than remaining, ocular quad almost as wide as long; Cephalothoracic sternum broad and pointed posteriorly, labium longer than wide and endites deeply curved on inner portion (Fig. 3), Chelicerae robust, bulging anteriorly on basal segment, armed with 3 on promargin and a row of 9-10 teeth on retromargin of fang furrow, fang



Figs 1-12: *Amaurobius indicus* sp. nov.
1. Female, dorsal aspects (legs ommitted); 2. Abdomen, lateral aspects; 3. Cephalothoracic sternum, labium and endite, ventral aspects; 4. Chelicera, lateral aspects; 5. Dentition on chelicerae, promarginal aspects; 6. Basal segment, mesal aspects; 7. Male palp, lateral aspects; 8. Male palp, mesal aspects; 9. Female palp, dorsal aspects; 10. Tarsus IV, lateral aspects; 11. Female epigyne, ventral aspects; 12. Female genitalia, dorsal aspects

more than half the length of basal segment, bent on middle portion and acutely pointed (Figs 4-6); Palps simple, elongated, armed ventrally with 5-6 longer setae on Tibiae and Tarsi, and 5-6 Trichobothries in a cluster placed almost at the centre on external surface, in both male and female (Fig. 9); Palps in male (Paratype) much elongated with shallow cymbium, armed with few longer setae and thickly clothed with short hair, paracymbium bulging at the base of cymbium (Fig. 7) with a pair of small spikes, a pair of short, straight but stout apophysis present on outside of Tibiae, outermost being longer and stouter (Fig. 8). Legs I-IV comparatively thin, long, smooth and shining, armed ventrally with 9-9, 8-8, 3-2, 3-2 anteriorly directed paired spine rows (Fig. 10); Leg formula 1432, calamistrum present on III & IV pairs, more prominently noticeable on 1/6th distal portions. Scapula prominent on III & IV pairs while claw tufts fringed prominently on all legs.

Abdomen: Longer than wide, dorsum covered with smooth scutum without any hair, a weak chitinous collar present on 1/3rd anterior portion along with pedicel in female. Female genitalia with a pair of clear dark spots (Fig. 11), internal genitalia with dark dumbbell shaped sacs (Fig. 12).

The anterior 1/3rd chitinous collar continues ventro-posteriorly up to 2/3rd of abdominal portion in male, male palp complicated (Fig. 8).

Type data: Holotype 1 ♀, Paratypes 1 ♂, 2 ♀♀, (2 ♀♀ genitalia dissected and kept in microvials separately), all in 70% rectified spirit, will be deposited in the National Collections, Zoological Survey of India, Kolkata.

Type locality: 40 kms, northeast of Khalapur, near Matheran, Dist. Raigad (Colaba), Maharashtra, India. Coll.: Dr. D.B. Bastawade, 13.xii.1987.

Distribution: So far known only from type locality.

Etymology: Named after country of collection and distribution locality i.e. India.

KEY TO *AMAUROBIUS INDICUS* SP. NOV.

— Anterior row of eyes more procurved, anterior and posterior lateral eyes placed together, ocular quad almost square, tibiae and metatarsi of I pair of legs armed below with 9-8 and 9-9 paired spines in male and female, leg formula 1432, male palp with elongated shallow cymbium and a bulging paracymbium with two short curved spikes and a pair of tibial apophysis, outer being elongated and straight than inner, female genitalia with a pair of dumbbell shaped darker sacs .... *Amaurobius indicus* sp. nov.

— Anterior row of eyes less procurved, anterior and posterior lateral eyes placed away from each other, ocular quad almost rectangular, tibiae and metatarsi of I pair of legs with 4-4 and 6-6 paired spines in male and female respectively, leg formula 1423, male palp with short and deeper cymbium with a simple coiled paracymbium and with a stout curved tibial apophysis, female genitalic sacs triangular in shape and clear ones. .... *Amaurobius andamanensis* Tikader

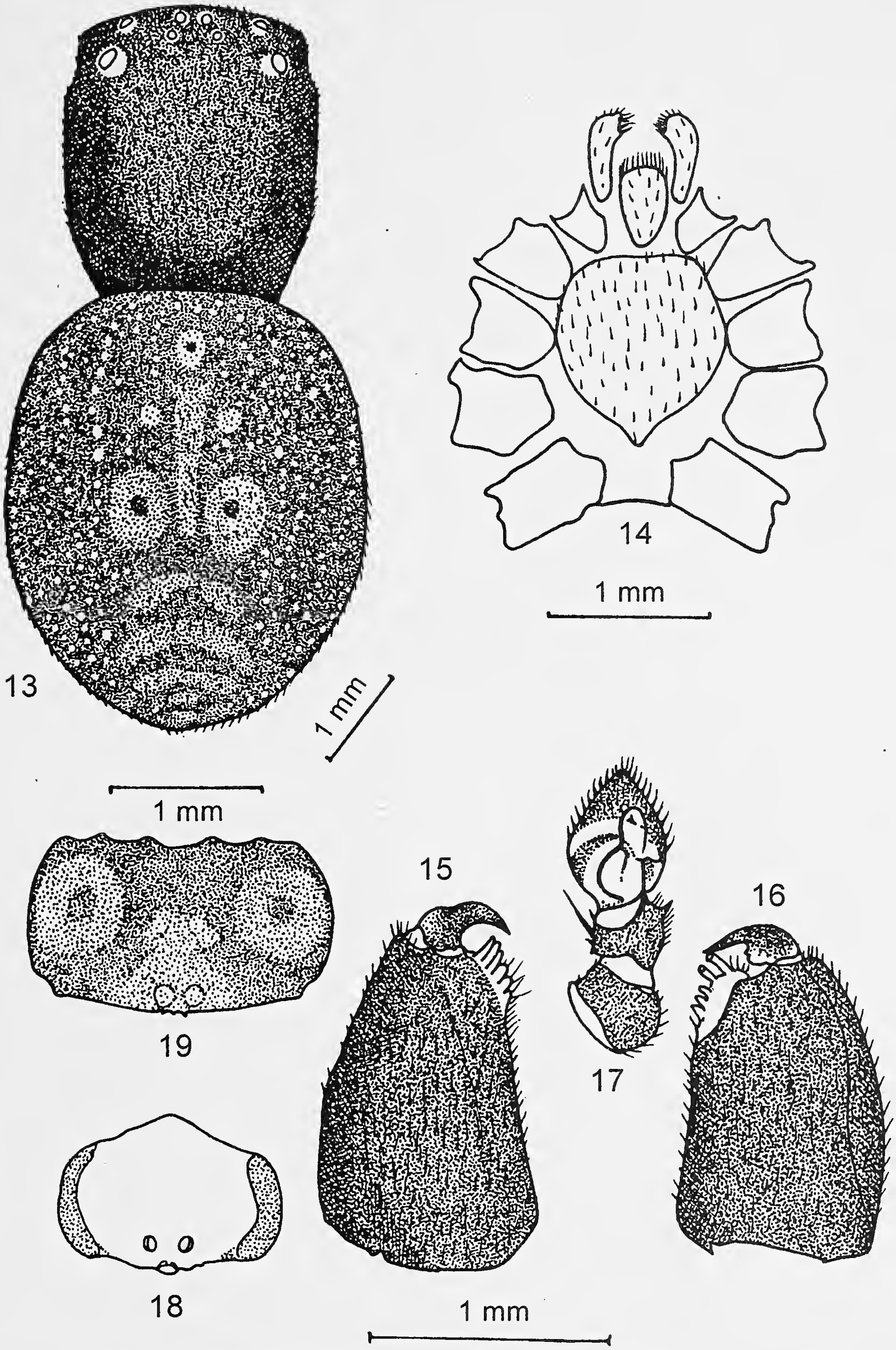
FAMILY: THOMISIDAE

Camericus bipunctatus sp. nov.
(Figs 13-19)

General: Crab-like appearance, dark brown to blackish, lighter on abdomen with a pair of conspicuous light yellowish spots on mid-dorsal portion, legs robust and dark brown to blackish-brown (Fig. 13).

Measurements (in mm): Total length 7.00; Cephalothorax 2.90 long, 2.20 wide; Abdomen 4.10 long, 3.80 wide.

Cephalothorax: Wider than long, uniformly dark brown, more darker on lateral portions, stalks of lateral eyes conspicuously



Figs 13-19: *Camericus bipunctatus* sp. nov.
13. Female, dorsal aspects (legs ommitted); 14. Cephalothoracic sternum, labium and endite, ventral aspects; 15. Chelicera, dorsal aspects; 16. Chelicera, ventral aspects; 17. Male palp, mesal aspects; 18. Female epigyne, ventral aspects; 19. Female genitalia, dorsal aspects

yellow, entire surface finely punctate, sparsely and finely rugose, more or posterior portion, clothed with fine short hair, ocular quad longer than wide, both the rows recurved and anterior lateral eyes situated on shorter stalks and posterior lateral not placed nearer to the posterior medians and small in size (Fig. 13), sparsely clothed with short hair; Cephalothoracic sternum small, inverted pear shaped pointed posteriorly, labium small narrow, longer than wide and endites curved inside on anterior portion (Fig. 14); Chelicerae dorsoventrally compressed on basal segments, narrow distally, finely granular on dorsal portions, weakly and sparsely clothed with short hair, promargin outstretched and armed with 6 denticles (Figs 15, 16), boss small, triangular fang very short, less than 1/3rd of basal segment (Fig. 15).

Palps short and slightly flattened on tarsi, clothed with short hair. Legs I & II longer and robust, darker than III & IV and also thickly clothed with short setal hair on ventral and interior portions of Tibiae and Tarsi of I & II, all legs finely punctate, rugose on ventral portion of femora, sparsely haired with short hair. All legs armed with a pair of claw anterior being stronger.

Abdomen: Almost elliptical, longer than wide, soft, dorsal portion with a pair of conspicuous, round, yellowish-brown mid-dorsal spots with a small central reddish dot along with three smaller spots, single on anterior median portion, while a pair between the larger median spot and a central smaller spot (Fig. 13), dorsal portion other than these spots covered with serially beaded lines but lighter in color (Fig. 13), entire body clothed with short setae. Two pairs of short and stumpy spinnerets present on posterio-ventral portion. Genitalia as in Figs 18 & 19.

Measurements (in mm): Total length 5.65; Cephalothorax 2.15 long, 1.90 wide; Abdomen 3.50 long, 3.10 wide; Male palp with short cymbium and thin minute transparent paracymbium (Fig. 17).

Type-data: Holotype 1 ♀, Paratypes 6 ♀♀, all in 70% rectified spirit (♀ genitalia dissected and kept in micro vial). Male paratype smaller in body size, also lighter in colour.

Type locality: Near Tulsi Lake, Sanjay Gandhi National Park, Near Mumbai, Maharashtra, India collected from under loose bark of a fallen tree. Coll. Dr. D.B. Bastawade, 27.ii.1997.

Distribution: Thane, Nasik (1 ♀), and Dhulia districts, Maharashtra and West-Kameng District, Arunachal Pradesh, India. (Specimens collected from Arunachal Pradesh are small in body size and paler in body colour).

Etymology: Named after the two prominent spots present on the dorsal surface of the abdomen.

KEY TO *CAMERICUS BIPUNCTATUS* SP. NOV.

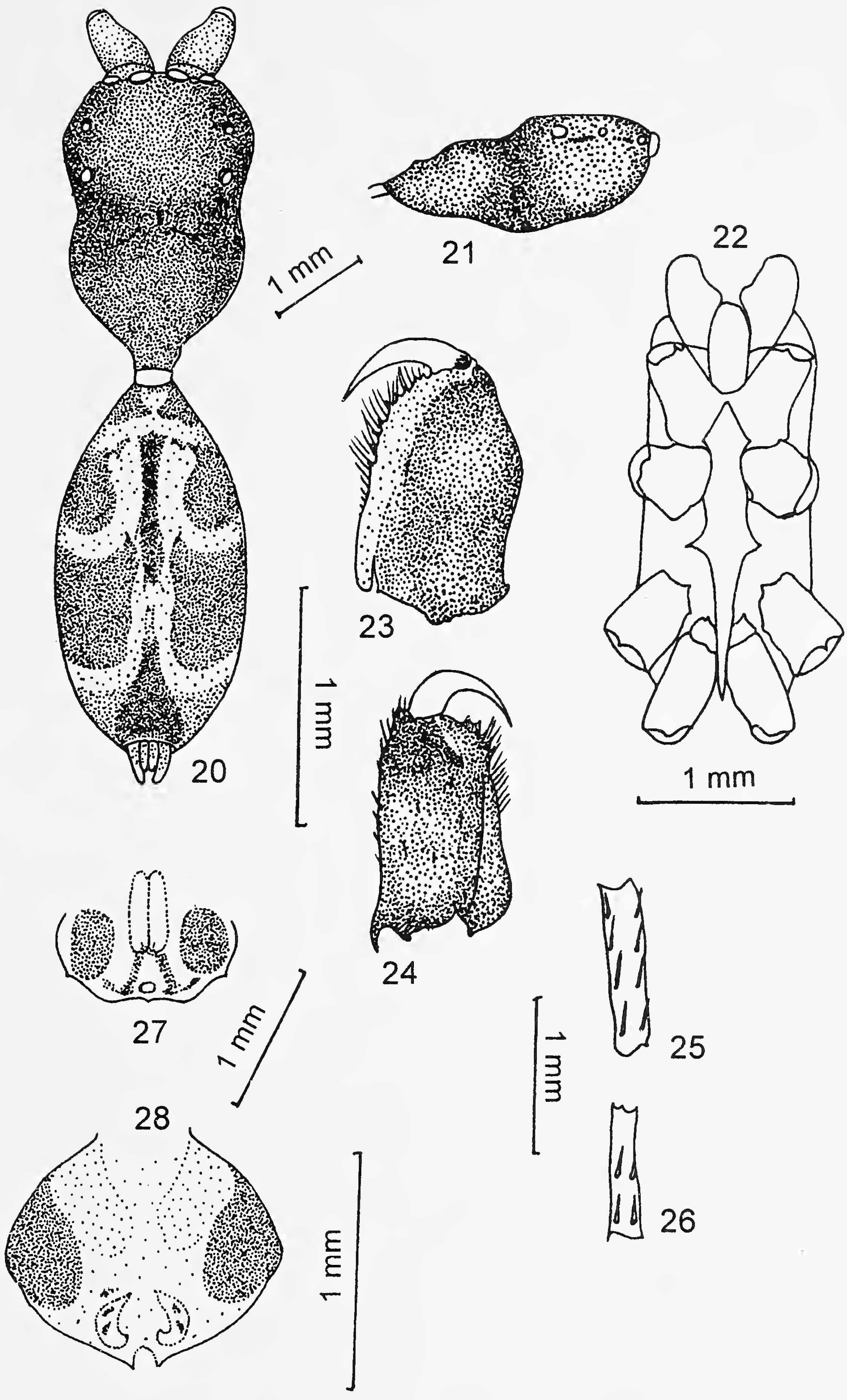
— Anterior and posterior median eyes placed very close to anterior median portion and situated away from lateral eyes, dorsal surface of abdomen bears a pair of conspicuous elliptical spots in the middle with dark reddish central portion and rest of the abdomenal portion decorative with light beaded lines, I and II pairs of legs thickly clothed ventrally on tibiae and tarsi and uniformly brown to blackish in colour, Female epigyne and male palp structurally different .... *Camericus bipunctatus* sp. nov.

— Anterior and posterior median eyes placed more on lateral portion close to lateral eyes, dorsal surface of black abdomen decorative with an inverted chalk white anchor shaped patch, tibiae and tarsi of I and II legs not so thickly clothed and patched with black in female, female epigyne and male palp structurally different... .... *Camericus formosus* Thorell

FAMILY: SALTICIDAE

Myrmarachne dirangicus sp. nov.
(Figs 20-28)

General: Ant-like spider, blackish-brown,



Figs 20-28: *Myrmarachne dirangicus* sp. nov.
20. Female, dorsal aspects (legs omitted); 21. Cephalothorax, lateral aspects; 22. Cephalothoracic sternum, labium and endite, ventral aspects; 23. Chelicera, dorsal aspects; 24. Chelicera, ventral aspects; 25. & 26. Tarsi I & IV, ventral aspects; 27. Female epigyne, ventral aspects; 28. Female genitalia, dorsal aspects

more blackish on cephalic region while light brownish on thoracic region, abdomen with two pairs of narrow lateral whitish bands, median anterior portion darker with a blackish patch on posterior portion (Fig. 20), light brown to yellowish-brown on ventral portion; Chelicerae brown, palps dark blackish on distal segments, legs darker on exterior margins and on joints, otherwise pale brown. Anterior median eyes larger than others and pearly white.

Measurements (in mm): Total length 7.10; Cephalothorax 2.90 long, 2.00 wide; Abdomen 4.20 long, 2.00 wide.

Cephalothorax: Longer than wide, cephalic region high and flat, posteriorly sloped into a shallow constriction and continues posteriorly into thoracic region, further narrowing posteriorly in to a pedicel (Fig. 21), entire surface smooth, clypeus narrow and not high, eight eyes placed in two rows, anterior two pairs placed in front in a row, median pair being larger and pearly white; posterior row deeply procurved, the medians being shifted much laterally almost in a same line to posterior laterals and much smaller in size (Fig. 20), ocular trapezium wider than long; Cephalothoracic sternum elongated and acutely pointed posteriorly, labium elongated with lateral margins parallel, rounded on anterior margin, endites narrowed behind to accommodate labium (Fig. 22); Chelicerae depressed from sides, almost quadrangular, with a ridge on interior surface, basal segments armed with promarginal and retromarginal row of 10 and 4 minute teeth respectively (Figs 23, 24), fangs pointed and almost 1/3rd of basal segment. Palps short as compared to body length, dorsoventrally flat and expanded, fringed ventrally with short setae and other portion covered with hair, a long Trichobothridial hair present on proximal portion of Tibiae. Legs I-IV thin, in 4312 formulae, Tibiae I with 4 pairs, and II with 2 pairs of anteriorly directed ventral spines (Figs 25, 26), Tarsomeres fringed with short setae.

Abdomen: Longer than wide, entirely smooth, leathery except the Epyginal portion, covered with short hair, with two lateral oblique bands (Fig. 27), internal genitalia with a pair of sacs, curved on inner portions and each sac bears two dark spots in it (Figs 27, 28).

Type Data: Holotype 1 ♀, Paratype 5 ♀♀. Holotype ♀ dissected for genitalia and kept separately in micro vial, all in 70% rectified spirit, will be deposited in National Collection Zoological Survey of India, Kolkata.

Type Locality: 15 kms O' Dirang, West-Kameng District, Arunachal Pradesh, India. Coll. Dr. D.B. Bastawade, 22.ix.1990.

Distribution: So far known only from type locality.

Etymology: Named after the type locality Dirang.

Key to *Myrmarachne dirangicus* sp. nov.

Cephalothoracic region broad and short than the abdomen, cephalic and thoracic junction not much constricted and shallow, cephalic region blackish with white tinge, whereas thoracic region brownish, the abdomenal coloration and female genitalia entirely different structurally .... *Myrmarachne dirangicus* sp. n.

Cephalothoracic region narrow and more elongated than abdomen, cephalic and thoracic junction much constricted and deep, cephalic and thoracic regions totally brownish, colour pattern on abdomen and female genitalia entirely different structurally.... .... *Myrmarachne bengalensis* Tikader

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undertake this work. I thank Mr. P.W. Garde, Artist Gr. I, WRS, Pune for the drawings, and my mother and wife for their constant co-operation during the work.

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REVIEWS

1. WATERBIRDS OF NORTHERN INDIA, by J.R.B. Alfred, Arun Kumar, P.C. Tak and J.P. Sati, 2001. Published by the Director, Zoological Survey of India, Kolkata. Pp. xxiv + 239, (21 x 14 cm). Price Rs. 200/- paperback, Rs. 750/- hard bound.

There is a pressing need, in India, to bring out regional bird guides. The WATERBIRDS OF NORTHERN INDIA has partially fulfilled this lacuna. Of the 245 waterbirds from India, this book covers 180 species recorded from Northern India (Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Uttaranchal, Delhi, Chandigarh and Uttar Pradesh). It claims to be an illustrated field guide, but not all birds are illustrated and some of the illustrations are sub-standard (e.g. Plates 7, 44). The book is full of valuable scientific data, but the presentation needs improvement. For instance, the size of the bar charts in Plate 41 could have been larger for better readability. Frequent spelling mistakes further decrease the quality of this otherwise useful book.

The authors have painstakingly described species with common and scientific names, size, status (resident, winter migrant, vagrant etc.), diagnostic characters, habits and habitat, food, and distribution. However, it is rather strange that purely dry and arid zone species (e.g. Indian courser *Cursorius coromandelicus*, stone-curlew *Burhinus oedicnemus*) are also included in this list. Lesser snow goose *Anser caerulescens*, of which we have only one confirmed record from India (Mundkur *et al.* 1992), has been included on the basis of a newspaper report. Someone claimed to have seen this north American species at Sukhna Lake in Chandigarh, which must have been a pair of the white variety of domestic goose *Anser indicus* that we find in many public gardens and ponds. Incidentally, Sukhna lake is a man-made artificial wetland, more appropriate for noisy picnickers than a stray snow goose!

Distribution maps of each species add value to this book, but unfortunately some are not accurate. The authors have perhaps depended too much on published records and not on intuition. When one depends totally on published records, then such maps show the distribution of ornithologists or recorders and not of birds. For instance, wigeon *Anas penelope* is suddenly shown absent in eastern Uttar Pradesh (p. 77), although this region has large wetlands; this species should be present there! Incidentally, there are very few bird watchers in this region. When this species is recorded all over India, then why should be it absent in eastern Uttar Pradesh? Similarly, shoveller *Anas clypeata* (p. 78) is also shown enigmatically absent in eastern Uttar Pradesh. The pheasant-tailed jacana *Hydrophasianus chirurgus* (p. 103) is absent in a small portion of northeastern Uttar Pradesh while it has been recorded across the border in Nepal as "fairly common on the Kosi marshes and proved breeding there" (Inskipp and Inskipp 1991, p. 140). I have reported it from Sitadwar and Pyagpur wetlands in Bahraich district of Uttar Pradesh (Scott 1989). Similarly, the distribution of the white-tailed lapwing *Vanellus leucurus*, the lapwing *V. vanellus*, grey-headed lapwing *V. cinereus* — birds likely to occur in any suitable area in northern Indian — is shown as disjunct (perhaps more to do with the presence of birdwatchers in these areas than the actual distribution of birds). There are many such mistakes in the maps. In case of common birds, likely to be found in all suitable areas, it is better to give a general distribution map, and if necessary mark out important sites or extralimital distribution.

The great white-bellied heron *Ardea insignis*, a very rare bird of Eastern India, has been shown occurring somewhere in the Uttar Pradesh-Haryana border, but the full reference is not given. Who recorded this species in Northern India? Unfortunately, the book is silent on such matters. The black-necked stork *Ephippiorhynchus asiaticus* (p. 55), on which I

did some work a couple of years ago and prepared a distribution map (Rahmani 1989), has been shown occurring only in Jammu, Himachal and north Punjab, but not in Uttar Pradesh where the largest known population occurs.

In the revised edition, some of the maps could be redrawn, and only those stray or vagrant records should be included that have been accepted by scientific journals. Unproven records (e.g. lesser snow goose, white-bellied heron) should be removed. Newspaper reports have no place in a scientific book.

■ ASAD R. RAHMANI

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2. ETHNOBOTANY OF THE PRIMITIVE TRIBES IN RAJASTHAN by Prabhakar Joshi, 1995. Published by Printwell & Rupa Books Pvt. Ltd., India. Pp. xv (not numbered) + 314 (24 cm x 16 cm). 14 coloured pages + 18 pp. illustrations. Price Rs. 750.00/$ 50/ £ 30.

This book is dedicated to Dr. S.K. Jain, pioneer and founder of the Ethnobotanical Society in India. It has a foreword by Dr. Pushpangadan and two pages devoted to acknowledgements!

The book, which is based on a doctoral thesis submitted to the University of Rajasthan, has 16 chapters and contains information not only on plants, but in the author's own words, has preponderant bearing on plants. A large part of it is irrelevant in scientific context. It speaks about false beliefs and superstitions, but provides few guidelines for future work or scientific inputs based on the author's studies. 75% of the information in the book looks outdated when one refers to the bibliography and information available in our state gazetteers.

A total of 172 plants of Rajasthan, used by tribals for various purposes, are mentioned, of which 72 are cultivated. The list of plants used for fencing, repelling porcupines, rats and crows, fish-poisoning, those yielding minor forest products like gum, oil-seeds, fruit, bark and flowers of commercial use are given with their local names like Ratanjyot, Swarnakshiri, and scientific botanical equivalents. Botanical names in the entire text are without author names.

The chapter on food plants contains a list of 92 edible plants including 15 famine food plants (reported after Maharda, 1985). Out of these, at least two plants *Celastrus paniculatus* Willd. and *Mucuna pruriens* Hook.f. are not safe for human consumption. *C. paniculatus* contains neuro-active compounds which in very minor doses are used for treating nervous system disorders. These compounds can cause nervous system disorders and even insanity in excess doses. Similarly, *M. pruriens* seed contains L-dopa, which is used for treating Parkinson's disease and is known to be harmful for normal human beings if consumed regularly. Seeds of *Terminalia bellerica* not only cause intoxication, but also act as violent purgatives and sometimes prove fatal. In fact, the author does not comment on the folklore in the context of the current knowledge of plants and their medicinal, economic or commercial utility.

The book lists 100 ethnomedicinal plants useful against 75 different diseases. The author mentions some primitive methods of treatment and suggests some advanced methods, which do not sound logical and may be left for consideration by medical experts.

The tribals of Rajasthan have important plants related to ceremonies, religion and superstitions, related to their deities, their myths, and for medicinal uses.

The book may be a good entertainer, but the amusement is a little too costly.

■ M.R. ALMEIDA

3. PARASITIC HYMENOPTERA AND BIOLOGICAL CONTROL by T.C. Narendran, 2001. Published by Palani Paramount Publications, Tamil Nadu. Pp. 190 (22.5 x 14.5 cm). Price Rs. 300; US $ 50.

Written for specialists by a specialist, the book contains keys to superfamilies and families with figures to most couplets. For each family a habitus drawing, a diagnosis, biological notes, major points on biological control, systematics and pertinent references are provided. Classification of major divisions of Hymenoptera, classification and general morphology of parasitic Hymenoptera, details on collecting and preserving, packing and shipping are also provided. Besides these, a separate chapter is provided on the importance of parasitic Hymenoptera in biological control of insect pests. The book will be a valuable source of reference for parasitic Hymenoptera, their host-parasite relationships and relation to biological control, not only to entomologists, agricultural scientists and biological control workers, but also to post-graduate students of entomology. More than 120 illustrations are provided. The foreword has been written by the highly respected entomologist Prof. M.S. Mani.

■ GAYATRI UGRA

■ ■ ■

MISCELLANEOUS NOTES

1. ON SOME LARGE-SIZED RED PANDAS *AILURUS FULGENS* F. CUVIER

(*With a text-figure*)

The red or lesser panda *Ailurus fulgens* F. Cuvier 1825 is a small carnivore rather poorly known, at least in the wild. It is found in the Himalayas in Nepal, India, Bhutan, northern Myanmar and China (Choudhury 1997, Corbet and Hill 1992). Its distribution in India has been mapped, and an interesting population discovered in Meghalaya (Choudhury 1997). During field surveys in northeastern India since the early 1980s, I have come across innumerable evidences of the red panda, from live animals to skins and stuffed specimens. Whenever I saw a skin or a stuffed animal, I took measurements. Here I report some large specimens, much larger than the known records.

The maximum recorded length of the red panda was 62.5 cm for head and body and 50 cm for tail (MacDonald 1984, Prater 1980). In 1996, I examined a skin at Tura in the Garo Hills, Meghalaya. The panda was shot in Nokrek National Park (approx. 25° 27' N, 90° 18' E) in the early 1960s, but the condition of the skin was excellent. It measured: Head + body length = 73 cm, Tail length = 43 cm (Choudhury 1997). It became the largest known specimen (skin) in the world.

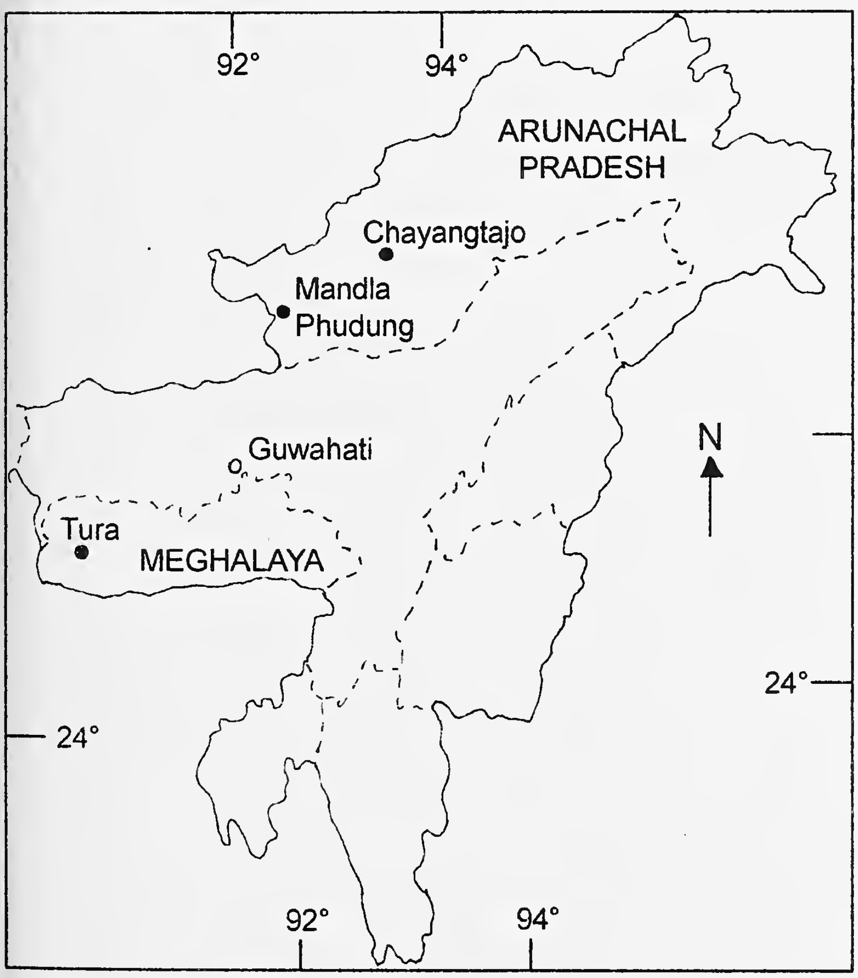

Fig. 1: Map showing the localities mentioned in the text

In May 2000, I came across a large skin at Tenga in West Kameng district, Arunachal Pradesh. It measured: Head + body length = 72 cm, Tail length = 50 cm. It was reportedly killed by road workers at Mandla Phudung area (*c*. 27° 16' N, 92° 06' E) in the same district in 1998. While its head + body length was slightly smaller than the Garo Hills specimen, overall length made it the largest ever recorded. However, this record was shortlived.

In May 2000 again, I saw another huge skin at Sangti, also in the same district. On enquiry, I learnt that it had been brought from Chayangtajo area (*c*. 27° 45' N, 93° 0' E) in East Kameng district, where it was killed by the Sulung tribals. It measured: Head + body length = 79 cm, Tail length = 43 cm. While in overall length the skin was the same as the previous one, the head and body were amazingly huge, the largest known in the world so far. Most intriguing was the fact that it still had some whitish colouring on its dorsum, indicating that it was not adult. One could imagine its size had it lived to adulthood!

I thank J. Datta, Mrs Lau, Bir Bahadur Gurung and Dr Tacho for help and for allowing me to examine the skins.

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Eds — It must be noted that these are measurements of skins and not of live animals or measurements taken before skinning.

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2. HUNTING ATTEMPT BY NILGIRI MARTEN *MARTES GWATKINSI* HORSFIELD, FAMILY MUSTELIDAE,IN PERIYAR TIGER RESERVE, KERALA

On December 16, 2000, a group of 11 persons led by the first author were participating in population estimation of tiger and prey base in the Periyar Tiger Reserve. At about 1000 hrs, we chanced upon a group of four Nilgiri martens *Martes gwatkinsi*, trying to hunt a mouse deer (*Tragulus meminna*), which we watched for about 10 minutes. The wounded mouse deer was moving about in a small pool of water with a steep bank on one side, and sandy dunes on the other sides. The martens had surrounded the pool, but did not venture into it. One marten tried to reach the mouse deer by moving down a root protruding into the pool from the bank.

On sensing our presence, the martens fled into the forest. The second author followed one of them to about 1.5 m, and photographed it on a tree. Soon, however, the animal moved down to 3 m from him, jumped into the undergrowth and disappeared. Meanwhile, one of us took pictures of the mouse deer in the pool. This happened in a rainforest dominated by *Cullenia exarillata*, by a trek path connecting Vellimala and Thamara, at an elevation of about 1,500 m.

The Nilgiri marten is listed in Schedule I of the Wildlife (Protection) Act 1972, and is endemic to the higher elevations of the Western Ghats. It has been rarely sighted, and even less is known about its feeding habits.

February 20, 2001

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3. POSSIBLE OCCURRENCE OF TIBET RED DEER *CERVUS ELAPHUS WALLICHI* IN ARUNACHAL PRADESH

(*With a text-figure*)

The Tibet red deer *Cervus elaphus wallichi* Cuvier 1823, also called the *shou* or Sikkim stag is a very rare and little known subspecies of the red deer *C. elaphus*. Once it was even thought to be extinct (Thornback 1978). At present, it is known only from southern Tibet (Schaller *et al.* 1996), though its original distribution included Bhutan also (Anon. 1976). During a visit to Bhutan in January 2001, I got reports of its possible occurrence in parts of Thrumshingla National Park, but no evidence was available.

During field survey for wildlife in western Arunachal Pradesh, I could not get direct evidence of the presence of the species, although older people reported a large deer with branched antlers (more branches than those of the sambar *Cervus unicolor*), which used to occur in the north. They called it *shou*. The sambar was not uncommon on the south-facing slopes of the Himalaya, especially in the deep valleys, mainly

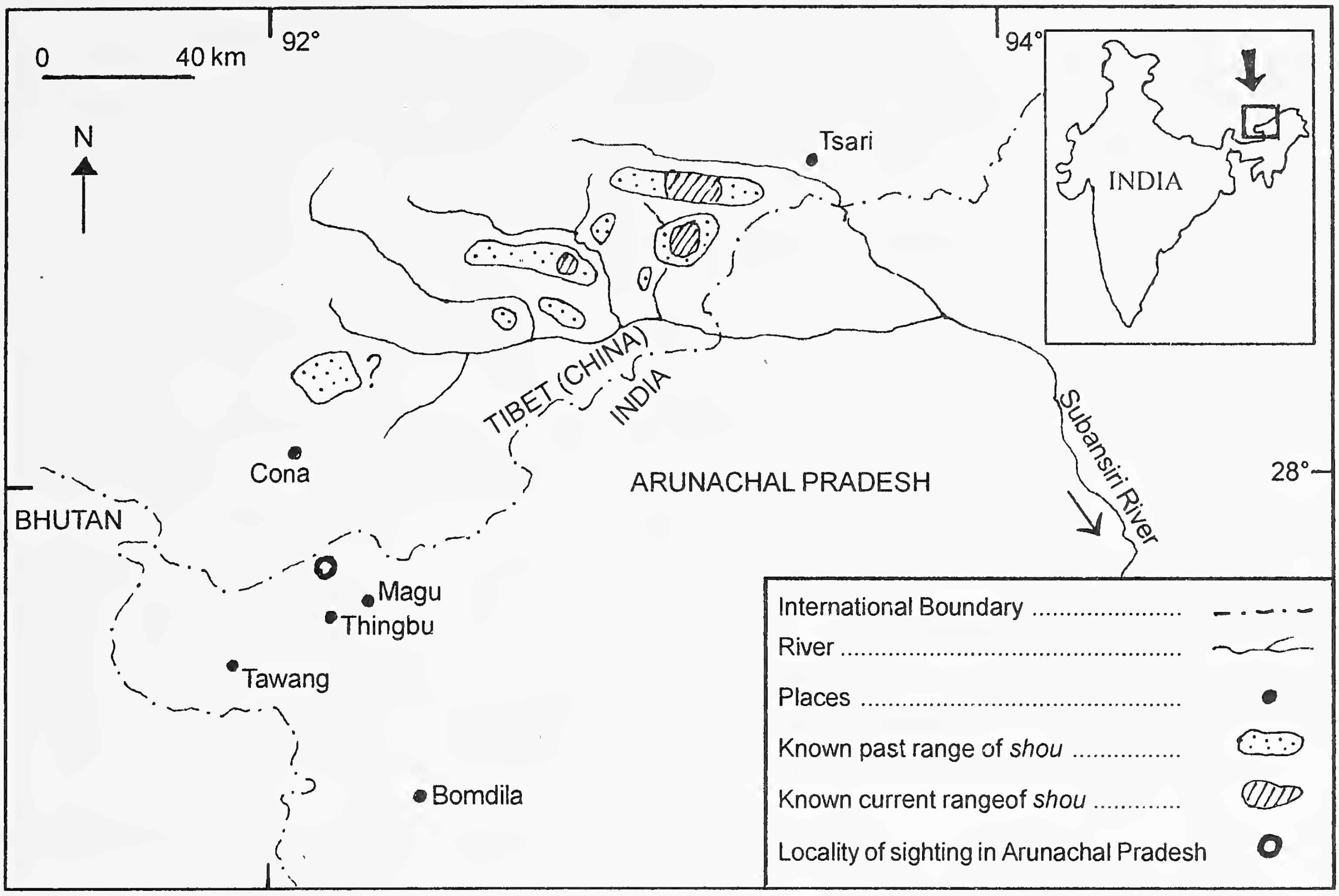

Fig. 1: Map showing the localities mentioned in the text and distribution of *shou*
(Note: there is one more locality which currently holds the largest population farther north; distribution in Tibet after Schaller *et al.* 1996)

below 2,000 m. In summer, it was recorded up to 2,600 m above msl (occasionally to *c.* 3,000 m) in the Himalaya in western Arunachal Pradesh. However, a report I received during my visit to Thingbu (27° 42' N, 92° 06' E) in Tawang district in May 2000 seemed to be an intriguing one, as it could be the only recent record of the *shou* in India. It was reported from north of Thingbu, very close to the India-China (Tibet) International Boundary on alpine pastures. A stag with "big" antlers was seen around noon at a place that was a six-hour trek from Thingbu (approx. 27° 47' N, 92° 06' E) in the summer of 1999 (Chombey Tsering of Thingbu, pers. comm.). The elevation of the place was more than 4,200 m above msl. The locals including the persons who sighted it had identified it as *shou*. During summer, many villagers move up with their domestic yaks, setting up seasonal camps at high elevation pastures, an example of transhumance. However, in recent years they had never came across any *shou*. They also said that the deer usually remains in open woodlands with stretches of grassy areas, but this sighting in a completely open grassy slope has surprised them and they observed it as long as it was within their sight. Occasional sighting of *shou* has also been reported from north of Magu about 4,000 m above msl (Perna Youndi of Jang, pers. comm.).

Some Monpas of Tawang and northern areas of West Kameng, the main tribal group inhabiting western Arunachal Pradesh, often call all large deer as *shou* (including the sambar). However, sambar has different names among most of the Monpas, *gasha* in most of the areas and *shawa* in Zemithang area. But in that locality,

north of Thingbu, high up on the alpine pastures of the Great Himalaya, the sambar is out of the question. Schaller *et al.* (1996) also mentioned that even in Tibet, it is confused with the white-lipped deer *Cervus albirostris* by the locals (as both are called *sha* by the Tibetans), but that is not the case here, as the range of *albirostris* is nowhere near the Indian border.

From the map in Schaller *et al.* (1996), it appears that the upper reaches of the Subansiri river could still hold some potential *shou* habitat, as no survey has ever been carried out in that portion to date (Fig 1). Gee (1964) also suspected the presence of a few *shou* in the area.

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4. HIMALAYAN MARMOT *MARMOTA BOBAK* (MULLER) RESIGHTED AFTER EIGHT YEARS AT KYONGNOSLA ALPINE SANCTUARY, EAST SIKKIM

The Himalayan marmot *Marmota bobak* has been regularly observed in the trans-Himalayan region of north Sikkim in Lhonak valley, Lashar and Yumesamdong valleys, and the Chho Lhamo plateau at altitudes from 4,500-5,500 m. In July 1992, four adult marmots were recovered from captivity from Kerang on the Chho Lhamo plateau and from Pegong near Tsungthang in north Sikkim, but could not be released in the wild due to various logistic and other problems. They were brought to the Head Office of the Department of Forests, Environment & Wildlife at Deorali, Gangtok (1,500 m). They had been tied with wires and their teeth were broken. As the office had no facilities or experience to treat or keep them, they were taken for release almost immediately to a higher altitude, to the 31 sq. km Kyongnosla Alpine Sanctuary (*c.* 4,000 m) around 20 km from Gangtok on the way to Natu La in East Sikkim. There was no opportunity to age or sex them, as the animals were highly stressed and held in wooden cartons.

The site of release within the sanctuary was at Namnang, beyond an area locally called Raja Dhunga, or King Rock. The sanctuary staff, Bishnu Kumar Sharma and Jeevan Kumar Rai, released the animals. They were infrequently observed in the area for a short period, after which they were not seen. It was presumed that the already traumatised animals did not survive in this unfamiliar terrain.

However, one adult marmot was resighted on August 24, 2000 at 1645 hrs about 4 km from the site of release in the Sola Firing Range area. The same two staff who were patrolling the sanctuary, spotted the marmot. The animal emerged from beside a big rock, a short while after it stopped raining. They observed it for about 10 minutes from a distance of *c.* 50 m, feeding on grasses and herbs. It hid when approached. The spot was very close to the owner of a yak ‘goth’ — (cattle camp) Mr. Sangey Sherpa, whose son also saw it. He informed that another marmot had been sighted further up from this site.

It might not have been such a good idea to introduce the injured animals to this sanctuary with predators like hill fox *Vulpes vulpes* and

yellowthroated marten *Martes flavigula* and with apparently no history of marmot occurrence (C. Lachungpa, *pers. comm.*). However, it is interesting to note that two may have survived the ordeal, and it is an indication that marmot life span in the wild could be at least eight years.

Feb. 27, 2001 USHA GANGULI-LACHUNGPA
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5. TWO WHALE RECORDS FROM TAMIL NADU, SOUTHERN INDIA

Recently, the media reported two different occurrences of a large whale running aground in Tamil Nadu.

The first of these instances took place in November 2000. Newspapers and television channels reported that a whale was stranded near Point Calimere. Their accounts said that the whale was stuck in mud and that it had been languishing there for 40 days or more. On November 14, the Coast Guard and others attempted to rescue the stricken animal and I was able to witness this effort from close quarters.

The whale was stranded in *c.* 1.25 m water at a location south of Point Calimere that took about an hour to reach by trawler. The bottom was clayey, and the water was quite brown and muddy. Further, the only parts of the whale that appeared frequently above the surface were its blowhole and snout. Nevertheless, over the course of the operation to save the creature, I was able to note the following features:

Shape: slender and long.

Length: about 12 m, roughly equal to that of the trawlers used to move it.

Dorsal fin: triangular, backward slanting, about 30 cm high; trailing edge frayed. Placed at about two-thirds the total length of the whale, from the snout.

Tail flukes: large.

Flippers: could not be seen.

Colour: black overall; belly white, possibly a little pink. Large white scars on the back between the blowhole and the fin.

Rostral ridges: three distinct longitudinal ridges running from the blowhole towards the tip of the snout, the middle one considerably more raised than the other two.

On the basis of these observations, I identified the stranded whale to be a Bryde's whale *Balaenoptera edeni*. The three ridges on the top of the head are diagnostic (Jefferson *et al.* 1993, Leatherwood and Reeves 1983, Watson 1981).

The second whale came ashore near Poothurai village of Kanyakumari district. On January 18, 2001, *The Hindu* carried an item about this whale. It said that a stranded whale was rescued by the villagers and officials, and had swum back to the sea. The Tamil newspaper *Dinakaran* carried a colour photograph of the whale on the same day, lying at the edge of the water. The caption said that the whale was "50 feet long and 10 feet high". According to this paper, the whale was entangled in fishermen's nets and was brought to the shore.

The snout and right side (front part) of the whale are visible in the published photograph. The whale was evidently a humpback *Megaptera novaeangliae*: it had the throat grooves or ventral furrows characteristic of a rorqual; its flipper appeared long and narrow, and it had the unmistakable knobs on top of the head. Further, no ridge was visible along the midline on top of the head, and the colour of the animal was black and white.

After intense search of the literature, I found only a few records of the Bryde's whale and humpback whale from India:

Bryde's Whale

i) Date not known, recorded by Blanford

from the Bay of Bengal (De Silva 1987).

ii) July 2, 1979, a 13 m specimen washed ashore at Beypore, Calicut (Lal Mohan 1992).

iii) February 20, 1983, 13.52 m carcass found on an islet near Dhanushkodi Island, Gulf of Mannar (Lal Mohan 1992).

iv) April 14, 1982, Leatherwood (1984) observed 7 Bryde's whales on a cruise from Madras to Trincomalee.

Humpback Whale

i) January 23, 1941, 14.7 m (49 ft) long whale stranded on the Anjengo coast near Quilon (Mathew 1948).

ii) January 15, 1988, 14.3 m long female specimen washed ashore near Kasaragod (Lal Mohan 1992).

iii) January 20, 1988, decomposed 15 m long female specimen found at Mavila Kadappuram, near Nileswaram, Kerala - drifted back into the sea after two days and appeared on January 24 at Thaikadappuram (Muthiah *et al.* 1988).

I am not able to determine whether the last two records refer to different specimens or just to one.

The limited information available on these species in India makes the present records noteworthy.

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6. A COMMENT ON THE REVIEW OF "PRIMATES OF NORTHEAST INDIA" PUBLISHED IN *JBNHS* VOL. 97(3)

With reference to the above-mentioned review, I would like to point out the following errors. The review of PRIMATES OF NORTHEAST INDIA, Srivastava (1999), by Gavand (2000) has failed to detect some serious errors. The main problem in this work lies in the maps and text. Zoogeographical complexities have made *faux pas* very difficult in Northeast India, e.g., the River Brahmaputra and many of its tributaries such as the Dibang, Manas and Sankosh are effective barriers in the dispersal of many mammals.

The capped langur *Trachypithecus pileatus* does not occur between the Siang and Dibang rivers in Arunachal Pradesh, but the map on p. 163 shows as many as three sites in that region.

What was the basis and source of these? There is no indication as to whether it was the author's own observation or other source. This area is a "no langur" zone and so far none have been sighted. If any sighting has been made, then it should be highlighted with specific data, as it would be a very important record. Even in China (Tibet), no langurs were recorded immediately to the east of Yarlung Zangbo (Siang or Brahmaputra) (Choudhury 1997, Qiu 1997).

Phayre's leaf monkey *Trachypithecus phayrei*'s northern limit of distribution in Assam is the Barak river, but the map on page 168 shows that it occurs beyond, even reaching the Meghalaya border! The author did not show the Barak river but the site shown was apparent as well beyond (the northernmost site shown on the map). The distribution of *T. phayrei* in Assam is already mapped (Choudhury 1988, 1994a, b) but the author did not review these records, although some are published in the well-known *JBNHS*.

So far, there is no record of the rhesus macaque *Macaca mulatta* in the higher areas of western Arunachal Pradesh such as Tawang district and upper areas of Kameng. The published records from Tawang (Singh 1991) were based on misidentification of Assamese macaque *M. assamensis*. Unlike other parts of Arunachal Pradesh where the primate is hunted for food, this species is common all over Tawang and Kameng, due to local tradition (the Monpas do not kill primates). But on the map on p.143, rhesus macaque was shown to occur in Tawang and upper areas of West Kameng (2 dots each). The location of Tawang district is conspicuous on the map of Arunachal Pradesh as it forms the western extended arm penetrating inside Bhutan and Tibet.

On p. 156, the distribution of golden langur *Trachypithecus geei* did not show Chakrashila Sanctuary, or the other nearby locations totalling more than 10. Not even a single dot put for more than 10 sites! Rather, Dhubri township with a human population of about 80,000 was shown as an isolated location. These locations are already mapped (Choudhury 1992).

In the text, perhaps the most serious matter is the observation on the feeding profile and home range of Phayre's leaf monkey in Murlen National Park, Mizoram (p. 167-8). Who has observed it in Murlen? My last visit to Murlen was in February 2001. So far, no observer has recorded it within the Park, although I was able to confirm its presence this time outside in the lower river valleys. The forest officials and staff who had accompanied all the survey trips (only a handful hence they easily remember) including that of the author's in Murlen since 1994 (it is mandatory to take authorised forest staff) did not report sighting Phayre's leaf monkey. Other observers on specific survey for this species could also not confirm it (Joydeep Bose, recipient of a National Geographic Society grant for the study of *T. phayrei*, pers. comm.). Anon (1994-99) which forms the basis for this book, as is evident from its Foreword and Preface, also does not mention sighting the Phayre's leaf monkey in Murlen. The Park is a high elevation area with most parts above 1,000 m (up to >1,600 m) but on p. 167, it was mentioned that the leaf monkey occurs up to 800 m only. Thus, the author himself has ruled out its presence in areas above 800 m, whereas the Park is higher. Then how could it occur in Murlen?

It is clear from Anon. (1994-99) that no field survey was carried out in Manipur, but the maps show some localities. What is the source of these? No mention in the text, or even in the reference section, of any published work.

Other noticeable errors, apart from spelling mistakes, were the conservation status of different species according to the Indian Wildlife (Protection) Act 1972. The stumptailed *M. arctoides*, Assamese *M. assamensis* and pigtailed macaques *M. nemestrina* are protected under Schedule II (Part I) and not Schedule I (pp. 135, 140, 150 respectively). The map on

the forest type on p. 53 and the accompanying text on p. 51-54 is poor. Subtropical pine forest shown even near Guwahati city! In the Himalaya, the temperate forest areas have been shown as subtropical or vice versa.

General comments I would like to make are that in a regional work, the distribution needs to be in greater detail, e.g., the stumptailed and pigtailed macaques are confined to the easternmost corner of Arunachal Pradesh. About 30 pages (p. 85-116) on food trees were wasted, as the plant part taken by the macaque is not mentioned. Huge introductory chapters (116 pages, more than 50% of the book) could have been restricted to 20-30 pages.

Furthermore, Phayre's leaf monkey's status as per the Wildlife (Protection) Act 1972 has been mentioned as Schedule I on p. 169, but as '?' on p. 186 [Table 8.1] In the same Table, the status of primates mentioned on pp. 135, 140 and 150 are contradicted, that too wrongly (Part I not mentioned). On p. 137, para 2, it is stated that the Assamese macaque occurs up to 4,000 m elevation, but the very next paragraph says it is up to 3,800 m. Again on p. 147, para 2, it is stated that the pig-tailed macaque occurs up to 1,200 m altitude, but the next para says it is up to 1,700 m. Which one is correct?

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7. "PRIMATES OF NORTHEAST INDIA" PUBLISHED IN *JBNHS* 97(3) — A COMMENT

Thank you for the opportunity to comment on the note on my book "Primates of Northeast India (1999). The critic has commented on three aspects of the review and the book: the literature search, field work conducted and distribution of primates.

The sections Preface, Foreword and Acknowledgments clarify the source of data set, field work conducted, literature search, scope of the book, genesis, and the objectives of the book.

Field Work: It is explicitly mentioned in the Acknowledgments and other places that the data set presented in this book is an outcome of my own field work covering 650,000 hectares of forests between 1994 and 1999, walking about 1,600 km on forests trails covering almost every state of Northeast India. I have also relied heavily on the observations of my colleagues and friends. As all this field work was carried out with many of my colleagues as part of a research team, I have taken extra care that no direct data are reported so that the academic rights of others are not compromised. This is normal academic ethics. However, more data are now analyzed and

published in journals of repute, giving everybody equal right of authorship. Additionally, the book aimed to provide firsthand information to common people and to an expert. If a reader is keen to obtain direct data, he is always welcome to read more scientific papers published elsewhere.

Literature Search: Apart from my personal collection of over 5000 reprints and 250 books on primates, I have consulted the world's best primate literature collection at Primate Information Center, Primate Center Library WRPRC at Wisconsin, Madison. The list of references with 195 citations clearly shows that the most authentic work is cited in the book. Therefore, it is not appropriate to say that I have not consulted relevant literature. Needless to say, one needs some criteria to choose from thousands of published and unpublished materials. The best a science student is taught to do in such circumstances is to select first the research findings published in referred journals with high citation index and/ or impact index, next choose published work in peer reviewed journals, books and lastly published material in unreviewed journals, newspapers and unpublished reports. Therefore, students are always advised to publish their work in reviewed journals for the maximum exposure.

Yet Another Data Point: It is not appropriate to question the dignity of a researcher who has a proven track record and I have the privilege of being trained by the best primatologists of the world, and have worked in the field and published results with them. I do not believe in Yet Another Data Point philosophy, rather I collect as much and as authentic detailed information as possible and test the hypothesis, and only then do I report my findings in reputed journals. This is the main reason why I have given only passing reference to my field observations as they are not published yet. Nevertheless, the quality of my research is clearly evident from the publications I have done with my research team. To make a comparative analysis please read Choudhury (1992) and Srivastava, *et al.* (2001a, b) on the distribution of golden langurs; Choudhury (1995-96) and Srivastava *et al.* (2001c) on Borajan reserve forest; and Choudhury (1999) and Srivastava *et al.* (2001d) on Primates of Gibbon Wildlife Sanctuary.

Physical Barriers and Dispersal: In earlier publications, some natural historians mentioned this area between the Siang and the Dibang rivers as 'no primate zone'. As more information is available now, it is referred as 'no langur zone' but before proposing such a theory, one needs to test this hypothesis, collect evidence and data to support it (which in this case is lacking). We have sighted capped langurs and rhesus macaques in this area we have surveyed between 1994 and 1999. If one has not observed the species in the area, it does not follow that the species doesn't exist, e.g., even after six visits to Hollangapara RF, Choudhury (1989) was not able to sight a single individual of stump-tailed macaque, though he later recorded one group (Choudhury, 1999). Here one needs to understand the phenomenon of dispersal, speciation through isolation and more importantly, the zoological time scale and climatic conditions before proposing such a theory. Often, the dispersal is more closely related to climatic conditions than postulated physical barriers that are apparently more impressive and effective at present than in the past. Generally, the Pleistocene glacial interval with reduced temperature, reduced rainfall, and increased seasonality has played a significant role in the dispersal of animals in the Indo-Chinese Peninsula (Heaney 1991). Verstappen (1975) identified three factors responsible for Quaternary climatic conditions in Asia, especially during glacials: (1) the position of the Intertropical Convergence Zone, (2) the worldwide drop in air and marine temperatures which resulted in lowering of snowline and forest line and affected altitudinal zonation of vegetation in the area, and (3) the emergence of shelves during glacials due to

lowering of sea level. Gross evidences derived from palynology, sedimentology and geomorphology suggests substantial cooler and drier climate over unglaciated continental areas at the end of the last glaciation about 18,000 years ago (CLIMAP 1976, Gates 1976). Two such periods of aridity may be the most plausible explanation for the apparent zoogeographical anomalies in Southeast Asia, including the disjunct distribution of primates (Brandon-Jones, 1978). Perhaps lowering of sea level explains the distribution of long-tailed macaque to Nicobar Islands in India. On the other hand, we have a fine example of speciation through reproductive isolation by an effective biological barrier for distribution of primates in India, the closely related species *Macaca radiata* and *M. assamensis* are separated by a biological barrier, *M. mulatta* (rivers have no role to play in this case).

I do not find any *faux pas* in the distribution maps for capped langur (page 163), rhesus macaque (p. 143), Phayre's leaf monkey (p. 168), and so on. All the sites mentioned in the maps are based on the surveys conducted by us between 1994 and 1999. A more detailed research paper highlighting specific locations of each population encountered is in preparation and will soon be available for comments (Srivastava, *et al.* In prep.).

If the critic can record the presence of Phayre's leaf monkey from Murlen National Park, why not others? The statement I have made on feeding and home range use is based on my observations (of course unpublished) of these monkeys inhabiting Murlen NP, Innerline Reserve Forest, Sipahijala WLS, and protected areas in northern Thailand. Incidentally, the altitude of Murlen National Park is between 400 m and 1897 m (Anon. 1996), and not above 1,000 m (up to >1,600 m) as reported in the note. The types of forest map on page 53 has been adopted from the classic work of Champion and Seth (1968), which was further modified by the Forest Survey of India (1997) and I do not find any *faux pas* there either.

The five volume compendium THE FLORA OF ASSAM by Kanjilal, 1997 (list price Rs. 1200/-) is extraordinary but out of reach of the common man. The forest is green for a natural historian, not only field biologists, even plant taxonomists fail to identify plants on the spot without flowers and fruits and/ or technical assistance. My attempt here was merely to introduce the concept of primate habitat and diet to the reader and foster greater interest in primate ecology. Most botanical descriptions are too technical for a layman and figures are often not available in Kanjilal (1997). Therefore, the section on plants is an important and useful component of my book. Similarly, the sections on the history, state profile and people of Northeast are important and meaningful. I quote Southwick (2000) "In the first two chapters, Dr. Srivastava wisely prepares us for understanding this diversity with profiles of topographic, climatic and economic conditions of each of the seven states of northeast India, along with discussions of their historical, sociological, and ethnographic backgrounds. This is a substantial, scholarly achievement and it appropriately sets the stage for better understanding some of the problems facing the remarkable biodiversity of this vital region ..."

Needless to say, I am aware of the typographical and editorial shortcomings of this book of mine, but surely they are not *faux pas*. As an author I hold ethical, moral and professional responsibility to attend to all these shortcomings in the next edition. Despite all the shortcomings I have received extraordinary remarks on the book by leading primatologists of the world.

In my considered opinion, it is not a crime to make available the facts and figures of science to a layman. I hope this note will help in the development and growth of field biology in general and primatology in particular in India.

October 25, 2001

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8. STATUS OF SPOT-BILLED PELICAN *PELECANUS PHILIPPENSIS*, FAMILY PELECANIDAE, IN GUJARAT

The spot-billed pelican *Pelecanus philippensis* is a monotypic species and is known to breed in Karnataka, Tamil Nadu, Orissa and Andhra Pradesh from November to March-April. Ali and Ripley (1983) state that it is resident and locally migratory in both Pakistan and all over India. Ali (1954) has listed *P. philippensis*, but has not commented on it. On the other hand, he has written comments and confirmed sighting of the great white pelican *Pelecanus onocrotalus*. However, confirmed identification of the two subspecies of *P. philippensis* was not specified. *P.p. philippensis* is not listed by Ali (1945) and Palin and Lester (1904). Dharmakumarsinhji (1954) does not include the nominate species *P. philippensis*, however, he has described both the Dalmatian *P. crispus*, and the great white pelican *P. onocrotalus*, which are winter migrants to the Saurashtra peninsula.

While scanning the literature, particularly on the Dalmatian pelican *P. crispus*, I realised that I had never seen *P. philippensis* in Gujarat,

though *P. crispus* was seen regularly, in small numbers, in the coastal regions of Saurashtra and freshwater reservoirs, including Nalsarovar Bird Sanctuary and Pariej and Kanewal reservoirs of Kheda district, in central Gujarat. However, midwinter waterfowl census reports (1987-1996) and other recent checklists show the occurrence of both the Dalmatian and the spot-billed pelican in Gujarat. I believed that this could be an error, partly because the observer may not have been able to distinguish between two subspecies. I discussed this matter with a few senior birdwatchers, asking them if they had seen *P. philippensis* in any part of Gujarat State. I requested them to send their comments, which are quoted below.

Shri Lavkumar Khacher: "I do not have any preserved records of sightings of the two subspecies and I am sure one of the greatest problems is going to be this total lack of qualitative data. You are absolutely correct about inaccuracy of identification by a number of birdwatchers. My impression is that the northern wintering bird is the one we see most frequently. Being great fliers (sic), however, it certainly does not preclude the southern bird from spreading north, but caution is necessary since the juveniles of Dalmatian might be passed off as the dark southern birds."

Shri M.K. Himmatsinhji: "As far as the spot-billed pelican *Pelecanus philippensis* is concerned, I have not come across it in Kutch. On what authority Ali and Ripley (1983) mention it as occurring in Pakistan is not clear to me. On the other hand, Roberts (1991) excludes it from the checklist of birds of Pakistan. It has been my experience over the years that one cannot lay down hard and fast rules about records or occurrence of birds in any given area or region. In this case, it can safely be said that this species has not been firmly recorded in Gujarat.

"The Dalmatian pelican *P. crispus* is an irregular migrant visitor, which whenever present is always seen in very small numbers (2-6 individuals) in this part of our country."

M.K. Shivbhadrasinhji: "I have not come across any spot-billed pelican *P. philippensis* in Saurashtra."

S.N. Varu: "I have not seen spot-billed pelican in Kutch though previously I was mistaken but afterward I confirmed that it was a Dalmatian pelican."

This matter was also discussed with Dr. Taej Mundkur (Wetland International, Malaysia) during February and November 1996. Till then, he had not seen *P. philippensis* in Gujarat. However, during his visit to Gujarat on August 14, 1999, he informed me of having seen a single bird amongst a few Dalmatian pelicans on Lakhota lake at Jamnagar during January 1999. This is the one reliable sighting from Gujarat.

The spot-billed pelican is an uncommon winter visitor in Rajasthan also. Though the species figures in the checklist of the Keoladeo National Park (Vijayan 1991), its sightings were rare (L. Vijayan *pers. comm.*). In the last ten years, it has rarely turned up at Keoladeo National Park (Vibhu Prakash, Bholu Khan, *pers. comm.*). It has not been recorded at Kota in southeast Rajasthan during the last few years (Rakesh Vyas *pers. comm.*, Vyas 1992). Since the species is so rare in Rajasthan, the possibility of its occurrence in Gujarat is doubtful.

The monotypic *P. philippensis* is known to breed in Karnataka, Tamil Nadu and Andhra Pradesh from November to March-April. Hence, the adult potential breeders are likely to move only to the breeding grounds rather than wander in the north-western states of India. Only immature birds are likely to wander away from the breeding ground during winter. This could be the major reason behind its rarity in Rajasthan and complete absence from Gujarat.

Regular records of this species in the Asian Waterfowl Census and subsequent publications (Perennou *et al.* 1994, Khacher 1996) may be due to confusion in identification or listing.

According to Khacher (op. cit.), there is lack of quality data collection. Besides this, I feel that the confusion is mainly due to the common English name grey pelican used by Ali and Ripley (1983) for *P. philippensis* and by Dharmakumarsinhji (1954) for *P. crispus*. Thus, it can be concluded that the occurrence of this species is not established in Gujarat state.

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9. A LARGE CONGREGATION OF BLACK-SHOULDERED KITE *ELANUS CAERULEUS* AT RANTHAMBORE NATIONAL PARK

Naoroji (1987) has reported a large communal gathering of over 15 black-shouldered kites from Ranthambore National Park, Rajasthan, India, on an afternoon in May 1984. A larger gathering of more than 50 kites was observed in the same Park, in the last week of May 1999, at about 1600 hrs near the Raj Bagh Lake (26° 01' 49" N, 76° 28' 03" E). Although the black-shouldered kite is distributed throughout India, such a phenomenon has not been reported from within the country. In Africa, it is known to roost communally, sometimes in very large congregations (Brown *et al.* 1982). Even at Ranthambore, though they are known to roost communally, such a large number has not been recorded so early in the day before roosting time (Naoroji 1987).

What is interesting is the striking similarity in both these observations that are 15 years apart and from the same area. During another research investigation, I had stayed for five continuous weeks, making trips (each of three hours duration) both in the morning and evening, everyday, but had not noticed such a gathering on any other occasion.

The species is known for its nomadic movements throughout its distributional range (del Hoyo *et al.* 1994) and in Africa is known to appear in areas with temporary rodent abundance and above average rainfall (Brown *et al.* 1982, Cramp and Simmons 1980). In India, especially at Ranthambore, it would be interesting to see if such gatherings occur every year and if local rainfall patterns or abundance of prey influences

it. Could such a gathering have significance in migration, seasonal or nomadic population movements?

ACKNOWLEDGEMENTS

I thank Dr. Asad R. Rahmani for his valuable suggestions and for the references. I thank Dr. M.B. Krishna for suggesting that I write this note and for his help with the drafts.

January 8, 2000

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10. ATTEMPTED FEEDING BY A SHIKRA *ACCIPITER BADIUS*, FAMILY ACCIPITRIDAE, ON BUFFSTRIPED KEELBACK *AMPHIESMA STOLATA*, FAMILY COLUBRIDAE

According to Ali and Ripley (1987), the food of the shikra *Accipiter badius* includes all live animals of manageable size, like mammals, birds, reptiles, amphibians and various insects. Its reptilian food includes various kinds of lizards, e.g. *Calotes versicolor, Mabuya carinata*, *Hemidactylus* sp., and *Lygosoma* sp. However, Naoroji (1985) recorded *Calotes versicolor* as its main food.

On January 7, 1999 while walking on the roadside along *Chander More*, a wetland in Murshidabad district, West Bengal at around 1400 hrs, I saw a shikra *Accipiter badius* cross the road in front of me and fly overhead, carrying a rope-like object in its feet. As it settled on an eucalyptus tree, some 70 m away, I moved quickly near the tree and found it was holding a small snake, 30-40 cm in length. I identified the snake as a buffstriped keelback *Amphiesma stolata*, the commonest snake in this area. The shikra had, perhaps, captured it in the nearby marsh as it came from that direction when I first saw it. The snake was still alive, and in trying to free itself, had coiled around the leg of the shikra, which looked uncomfortable. A few minutes later it flew off with its prey and I could not see the fate of the snake.

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11. ATTEMPT BY THE CRESTED SERPENT-EAGLE *SPILORNIS CHEELA* TO SEIZE THE INDIAN COBRA *NAJA NAJA*

On May 26, 1999, Mr. Neelimkumar Khaire, Director, Katraj Snake Park, Pune informed me about an injured crested serpent-eagle *Spilornis cheela*. The eagle was found in the Katraj Ghat, about 10 km south of Pune. While patrolling the Ghat section, the traffic police officer Mr. B.S. Divekar was shocked to see a bird falling from the sky, right in front of his vehicle. The officer soon realised that it was some kind of 'shikari pakshi' i.e. a bird of prey. To his great surprise, the bird was entangled with a cobra (*Naja naja*). He took a stick and tried to drive off the cobra by beating it on its tail. The cobra immediately raised its hood and launched false attacks. However, after some time, it slowly unwound itself and disappeared into a nearby nullah. Although the eagle was not very badly injured, it was soaked in the rain and unable to move.

Mr. Divekar brought the eagle to the Katraj Snake Park, where there is a section for injured animals. While examining the eagle, we found that it had been superficially bitten under the left eye, clearly noticeable by the fang marks from which some blood had oozed out and clotted. Two things struck me. In spite of its swiftness and ability to hunt snakes and lizards, this particular eagle could not manage its quarry efficiently. The snake managed to coil around the bird's wings in the air, making it lose control of its wings. The eagle was kept under careful observation in a cage. It was fed with small pieces of mutton, which it readily accepted. The need to give it snake antivenin was discussed. However, the shot was not given, as the eagle started showing signs of revival. To test the extent of the bird's revival, the Park management gave it small animal prey like chicken and guinea pig. The eagle immediately launched attacks and seized the prey. After having confirmed its ability to fly and physical fitness, the eagle was set free on July 9, 1999, by the Park authorities.

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12. BREEDING BY THE INDIAN COURSER *CURSORIUS COROMANDELICUS* IN WINTER IN RAIPUR, CHHATTISGARH, INDIA

On December 15, 1999, while bird watching, we visited the open wasteland (locally known as bhatas) near village Mand (Kharora), about 38 km on the Raipur-Balodabazar State Highway, district Raipur, Chhattisgarh. Apart from yellow-wattled lapwings (*Vanellus malabaricus*), ashy-crowned sparrow-larks (*Eremopterix grisea*) rufous-tailed finch-larks (*Ammomanes phoenicurus*) and Eurasian skylarks (*Alauda arvensis*), a flock of twenty Indian coursers (*Cursorius coromandelicus*) was also seen. At some distance from them, we sighted a solitary bird squatting on the open ground. The bird did not move till the vehicle had approached close, whereas the other birds had already moved to considerable distances. This behaviour aroused our curiosity and we approached closer. Thereafter, the bird moved away reluctantly, exposing two eggs on its open, scraped ground nest. The bird in the nest and the exposed eggs were photographed. The area around the nest was extensively examined, but no other nest could be located.

Subsequently, the site was visited on January 12, 2000 when another hen brooding two eggs was seen about 40 m away from the

first nest. A week later, i.e. on January 19, 2000, a second abandoned nest was found; no hen or chicks were seen; the eggshells lying nearby were collected.

Another nest with a hen brooding a clutch of two eggs was located on January 19, 2000 about 25 m away. The breeding season of the species is March to August. (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN; Ali, Sálim and S. Dillon Ripley, 1987, Vol. 3, Pp. 182). In this case, the eggs were being hatched in December and January, suggesting that the species breeds in winter in this region.

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13. SIGHTING OF A RUFOUS-NECKED STINT *CALIDRIS RUFICOLLIS* (PALLAS) IN WEST BENGAL, INDIA

On September 17, 1999, while observing a mixed flock of over 1,000 waders on the tidal mudflats of the alluvial Divar island in the inland-estuary of the Mandovi, Tiswadi tal, North Goa district, Goa, *c.*15 km up the mouth of the river, an odd wader caught our interest. For more than 15 minutes, we observed through 30 x 60 and 60 x 78 spotter-scopes, the mostly immobile bird and compared it with numerous curlew sandpipers *Calidris ferruginea*, little stints *C. minuta*, and broad-billed sandpipers *Limicola falcinellus* that were surrounding it.

Plumage: Virtually identical to little stint but markings less contrasting; pale V-shaped mark on mantle less distinct; crown less grizzled; buff wash on sides of breast stronger.

Size: Markedly longer than little stint; almost as large as broad-billed sandpiper, sometimes appearing as large as some of them. Distinctly stocky, plumper and heavier than the comparatively sleek little stint, like a half-grown red knot *C. canutus*.

Our observations of the plumage conform with those of Hayman *et al.* (1988) and Grimmett *et al.* (1998) for the non-breeding plumage of the rufous-necked stint which, however, are not conclusively identifying. It was the measurements that made us sure of the identity of this enigmatic wader.

TABLE 1
COMPARATIVE MEASUREMENTS OF SMALL WADERS

	Body length w/o bill (Hayman *et al.* 1988)	Average weight (Ali & Ripley)
Little stint	102-122, ave. 112 mm	20.6 g
Rufous-necked stint	112-142, ave. 127 mm	24.0 g
Broad-billed sandpiper	128-148, ave. 138 mm	32.2 g

The average weights given by Ali and Ripley (1983) might be misleading, since they were taken for each species in different seasons. However, Snow and Perrins (1998) state that the rufous-necked stint is, on an average, 30% heavier than the little stint. This, in connection with the rufous-necked stint's slightly shorter tarsus, accounts for the remarkable stockiness of the bird we had observed.

The rufous-necked stint, long considered conspecific with the little stint, is known to winter in SE Asia and Australasia, and in our region it is a scarce but regular winter visitor to the shores of Bangladesh and India's east coast. Our sighting is the first record of this species on the west coast.

November 9, 1999

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HEINZ LAINER
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14. OCCURRENCE AND ASSOCIATION OF RED-NECKED PHALAROPE *PHALAROPUS LOBATUS* WITH OTHER SPECIES AT SAMBHAR, RAJASTHAN

With its slim graceful body, slender neck, small head, needle-like bill and lobed toes, the red-necked phalarope *Phalaropus lobatus* is one of the most distinctive waders. It is an expert swimmer, readily distinguished from other waders by its ability to land on water.

Adam (1874) obtained specimens of this rare bird on September 22 and 25 at Sambhar. According to Ali and Ripley (1980), it has been "recorded from few inland localities on spring and/or autumn passage". Roberts (1991) says they "take flight to the sea coast non-stop, but occasional birds can be encountered on inland lakes or freshwater ponds on passage" and describes the status as "common but only offshore".

The purpose of this note is to report recent sightings of the red-necked phalarope at Sambhar lake and describe its foraging method in association with other feeding birds on passage. Twenty-seven red-necked phalarope were recorded at Kochia ki Dhani, a satellite freshwater wetland of Sambhar Lake on September 9, 1998. Eleven of them were swimming with six little grebe *Podiceps ruficollis* and picking up insects from the surface of the water. The other birds were paddling and spinning to bring prey to the surface.

In the afternoon of February 5, 1999, Denis Parkes, a British bird watcher, and I were watching waders at Kochia ki Dhani, Sambhar. Scanning the birds with my binoculars, I picked out a more lightly built bird and said that I had the red-necked phalarope. We counted 17 red-necked phalaropes on this freshwater pond. All of them were in 'off' plumage. They were staying in two to three groups around shovellers *Anas clypeata.* They were spinning around picking off flies disturbed by the ducks as they swam. As is customary with the genus when on inland waters, the group was not wary of us.

On September 5, 1999, Harsh Vardhan and I recorded four red-necked phalarope at the same site with seven or eight avocets *Recurvirostra avosetta*, presumably taking advantage of the prey or edible particles brought to the surface, or into view, by foraging avocets in a shallow part of the lake. All the phalaropes were actively following the avocets.

The explanation for this behaviour is that the red-necked phalarope "associate with the other feeding birds probably to benefit from the higher prey availability brought about by disturbance" (del Hoyo *et al.* 1996). According to Cramp and Simmons (1983), the red-necked phalarope feed in this manner "presumably to take advantage of prey brought to surface or into view". Two comprehensive books on the birds of the Subcontinent (Ali and Ripley 1980, and Roberts 1991) describe its feeding methods, but do not record its feeding association with other birds. This note provides additional information on the feeding behaviour of the species in the Indian Subcontinent.

December 16, 1999

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15. POMPADOUR GREEN PIGEON *TRERON POMPADORA AFFINIS* AND LARGE HAWK-CUCKOO *HIEROCOCCYX SPARVERIOIDES* ON THE PALKONDA HILLS, PENINSULAR INDIA

We visited Talakona Reserve Forest (13° 49' N, 79° 13' E) along with members of the Bird Ringing Training Programme, organized by the Bombay Natural History Society (BNHS), from August 27-29, 1999, led by the second author. We camped at the Andhra Pradesh Forest Department's Guest House Complex at the Siddeswaraswamy Temple. Talakona is *c*. 70 km northwest of Tirupati town in Chittoor district, Andhra Pradesh, and situated past Bhakarapeta near Nerabylu village in the foothills of the Palkondas, in what are collectively known as the Eastern Ghats. The hills that lie between Nerabylu and Mogilipenta, which is on the northeastern side, have several peaks higher than 1,000 m in this part of the Palkonda Range. Talakona is in the midst of a sacred grove, some 5 sq. km in area, with Semi-Evergreen jungle, including several endemic tree species (Anon. 1996: 14, 20, but specified location of Talakona on page 20 is incorrect). We bird-watched along a narrow 3 km stretch of riparian forest on either side of a perennial stream, Bugga Vagu. This is a frequently used pilgrim route that proceeds eastward from the temple and leads to the Talakona, or Papanasanam waterfall. One walks almost parallel to the stream most of the way, on a path at least 20-25 m above the water level, and affords excellent views into the canopy of the trees that rise from the valley below.

Large Hawk-Cuckoo
Hierococcyx sparverioides Vigors

While we were returning from the waterfall on the morning of August 28, 1999, a hawk-like bird flew on to a bare branch of a tall tree (*c*. 30 m), at eye level. In flight, we suspected it was a brainfever bird *Hierococcyx varius* Vahl. But through the binoculars it turned out to be a large hawk-cuckoo *Hierococcyx sparverioides* Vigors! It looked slightly bigger than *H. varius*, and a yellow circle was clearly visible around its orangish eye. It had very prominent dark grey horizontal bars on its white belly and its tail was distinctly banded dirty brown and dark grey. This will be the second published record of *H. sparverioides* from what are known as the Eastern Ghats in Andhra Pradesh State. The first was by Ripley *et al.* (1988: 553), who recorded two immature females collected by them at Jyothimamidi "in disturbed forest" on the "Vizag Ghats" (that lie in the Northern Circars section of Andhra Pradesh, north of the Godavari river) on February 23 and 25, 1985 (see also Taher and Pittie, 1989: 14). However, if the biogeographical sub-areas of Ghorpadé (*in litt.* 22-ix-1999 and map, 1999: 4) are scientifically more correct, the 'true' Eastern Ghats occur only south of the Godavari and east of the Western Ghats: the "Vizag Hills" and others north of the Godavari being 'incompatible' with them, and belonging to what Ghorpadé terms the Central Highlands

sub-area, which later reveal a distinct Himalayan influence and domination of sal (*Shorea robusta*) jungle that is absent south of the Godavari (Legris and Meher-Homji 1977). This means that our sighting is actually the first ever record of the large hawk-cuckoo from the true Eastern Ghats ecosystem. The HANDBOOK (Ali and Ripley 1987) mentions wintering and passage records of *H. sparverioides* from Madhya Pradesh, Orissa, Tamil Nadu, Karnataka and Kerala, indicating that this Himalayan-breeding cuckoo uses an easterly route to its wintering haunts on the Wynaad, Nilgiris, Palnis, and other highlands south to the erstwhile Travancore on the Westem Ghats (Abdulali 1949: 1985: 210). The present record from the Palkonda Hills is the second from Andhra Pradesh, and confirms this easterly migratory route of the large hawk-cuckoo.

Pompadour Green-Pigeon
Treron pompadora affinis (Jerdon)

Also on August 28, about half way to the temple from the waterfall, we were walking under an unidentified *Ficus* tree in fruit, when B. Raha, one of the participants, looked up and said "Green-pigeon!" Some 3-4 birds were seen moving in the canopy directly overhead, giving us a brief glimpse of themselves between the foliage. Just before all of them flew away, we got a better view of one green-pigeon and noticed that it had a maroon back. We were then sure it was a Pompadour green-pigeon *Treron pompadora affinis* (Jerdon), but we needed at least one more sighting to confirm its identity positively. So we returned that very evening at 1700 hrs, but could see no green-pigeons on the same tree. After some time, we started back and then, near the temple, about 7-8 green-pigeons flew over us and settled in a tree on the edge of the road, close at hand. One landed on a bare branch, clearly visible to all of us. Thus, we identified them as a flock of Pompadour green-pigeons! Ali and Ripley (1987) reported the distribution of this species and its habitat as "Western and southwestern India - the Western Ghats complex (including the Nilgiris, Palnis, and associated hill ranges) - from about 20° N southward through western Mysore (Malnaad) and Kerala. Affects forest and well-wooded country in evergreen and wet deciduous biotope; lowlands and up to *c.* 1200 m. altitude." Jerdon (1864) claimed to have "killed it in Central India, and in the Eastern Ghats" but gave no details of location or date! Sugathan (1983) reported that "One specimen of *T. pompadora* was ringed in 1969 at the BNHS ringing camp. Subsequently, two *pompadora* ...were ringed in April/ December 1970," in Point Calimere Sanctuary, Thanjavur district, Tamil Nadu (Krishna Raju and Shekar 1971). It is significant that Point Calimere is just 48 km away from Sri Lanka, separated by the Palk Strait, where *T.p. pompadora* (Gmelin) is "Resident subject to local movements" (Ripley 1982). Unfortunately, the race of this green-pigeon was not noted in both these instances (*teste* Balachandran). Abdulali (1985), however, questioned several identifications of Sugathan (1983), but Hussain (1985), who was the project in-charge at Point Calimere, attempted to justify most of these 'bird-in-the-hand' determinations. Surprisingly, Hussain (1985) refers to Sugathan's '*T. pompadora*' as "*pompadora affinis*", stating that "its occurrence in Point Calimere is noteworthy." The second author has regular sight records of pompadour pigeons during winter (October to February) from Point Calimere between 1981-1987. He also has sight records of the green-pigeon [= pompadour green-pigeon] from Tirumala...at Papanasanam (regularly sighted in flocks of 20-40) during 1989. Two of our bird watcher colleagues, who have visited this area, were contacted for information on this species/subspecies. Krys Kazmierczak (*in litt.* 20-ix-1999) quoted from his Talakona diary of 10-ii-1993, "*Treron pompadora* 10." Bharat Bhushan (in *litt.* 20-ix-1999) also recorded the 'Pompadour pigeon' in the Eastern Ghats. He recalls seeing it "at

different occasions ... near Mamandur (13° 42' N, 79° 27' E, Andhra Prades, [A.P.]), and also in a permanent patch of the peninsular endemic red sanders tree (*Pterocarpus santalinus*) near Renigunta (13° 35' N, 79° 30' E, A.P.). Further to these records, the second author has a sight record from Auroville (Pondicherry), where he saw a bird on a banyan tree in July 1996. It was the same race that breeds in the Western Ghats, (Balachandran and Alagarrajan 1997). Priya Davidar of Pondicherry University (in *litt.* 14-x-1999), informed that she has "not seen the grey-fronted green pigeon here (in Pondicherry) nor have any of my students. However, there is no reason why it cannot be a straggler here if recorded in other areas along the east."

This note is, therefore, a confirmation of Jerdon's purported first record of "*affinis*" from the Eastern Ghats, based upon positive identifications from Chittoor district and Pondicherry in Tamil Nadu State. The presence of *Treron pompadora* in Point Calimere is recorded, but details about race are lacking, preventing us from ascertaining whether the birds are *affinis,* or the nominate *pompadora* that is believed to be endemic to Sri Lanka. Further observations will clarify this matter in the Point Calimere region. The presence of this predominantly Western Ghats species or subspecies (known from 20° N near Mumbai to the Ashambu Hills in south Kerala and Tamil Nadu), on the Eastern Ghats, is significant, as it reinforces the "vicariance" model propounded by Ripley *et al.* (1988) — that these present-day peninsular rain forest 'relicts' are those now stranded in surviving, humid, forested refuges, associated with the rain-capturing scarps, on the eastern hill ranges (see also Daniel *et al.* 1986, for an endemic gecko of peninsular India, also rediscovered on the hills near the Tirumala temple).

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16. EURASIAN EAGLE-OWL *BUBO BUBO TIBETANUS* BIANCHI AT 2,100 M IN NORTH SIKKIM

On March 3, 1995 while on a visit to North Sikkim, we met an old hunter who had a big owl skin. On inquiry, he said that he had found the bird electrocuted by a high-tension wire at Khedum (*c.* 2,100 m) in Lachung Valley about two and a half months earlier, i.e. around mid-December, 1994. It had the following measurements:

Wing length	:	480 mm
Bill (From feathers)	:	232 mm
(From base of skull)	:	48 mm
Tarsus length	:	72 mm
Tail length	:	300 mm
Length of unstretched skin laid flat	:	68 mm

Its overall colour is pale buff and black, with dark heavy streaks on the breast and finely vermiculated streaks on the abdomen. The toes are completely feathered, with feathers overhanging and concealing the base of the dark, slaty claws. Local people from Gangtok identified it as 'Pwongma' (Lepcha) and 'Koiralo' (Nepali) and as the owl that "eats cats", the last possibly being the tawny fish-owl *Ketupa flavipes.* The hunter reported that its mate was still in the area, but so far we have neither seen nor heard of more of these birds.

Of the four subspecies of *Bubo bubo* (Linn.) in the Indian subcontinent, *Bubo bubo bengalensis* is the darkest and most richly coloured, both *B.b. turcomanus* and *B.b. hemachalana* are paler, while *B.b. tibetanus* is browner.

According to the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (1983) by Ali and Ripley, *B.b. bengalensis* is resident throughout the Subcontinent from *c.* 1,500 m (and rarely *c.* 2,400 m) in the western Himalayas up to west-central Nepal "...possibly further east, but not yet recorded from Sikkim, Bhutan or NEFA..."

Both *B.b. turcomanus* and *B.b. hemachalana* are recorded from the western Himalayas (Ladakh, Himachal Pradesh) and extralimitally from northern Pakistan, northern Baluchistan, and western Tibet right up to Kazakhstan.

According to Vaurie (1965: 587) *B.b. tibetanus* has "...Range within our limits hypothetical..." though it "...probably also inhabits the eastern Himalayas at high altitudes..." Thus, it may occur in northern Sikkim and perhaps also North Bhutan and NEFA..."

Considering the length, measurements, colour and locality, the specimen appears to be the Eurasian eagle-owl *Bubo bubo tibetanus*

Bianchi, which has an extralimital distribution in central and eastern Tibet (Lhasa, Gyantse, Khamba Dzong), areas that adjoin Sikkim. Sálim Ali does not mention this owl in BIRDS OF SIKKIM (1962). This specimen, now deposited in the BNHS collection, confirms the hypothetical occurrence of the species in our range from North Sikkim. It may be worthwhile to emphasize that *Bubo bubo bengalensis*, which is much smaller and darker, is also not yet recorded from Sikkim.

I thank the Sikkim Forest Department for enabling me to obtain this record.

Feb. 23, 2000

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17. ON THE STATUS OF *HYPOCOLIUS AMPELINUS* BONAPARTE IN THE INDIAN SUBCONTINENT

The hypocolius *Hypocolius ampelinus* Bonaparte (Family Bombycillidae) occurs in Afghanistan, S. Iran, Arabia and N. Africa where, in some areas, it is common and widespread. The HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali and Ripley 1972) describes the species as a rare vagrant, with individual examples seen and collected at long intervals in the Indian subcontinent. This opinion was supported by the fact that perhaps the first specimen was collected by Blanford on March 6, 1875 in the Larkana district, Pakistan followed by a record of Duke on April 20, 1877 in Kalat, Baluchistan (Pakistan). The HANDBOOK also mentions Sind (Karachi). It seems there were no further sightings of the hypocolius till Dr. Sálim Ali saw and procured a specimen from Kihim on November 14, 1930 (Ali 1931). Apart from this, there was also said to be a report of its occurrence in Madhya Pradesh. It was nearly thirty years later that a female and a male were collected in mist nets consecutively on March 22 and 23, 1960 at Kuar Bet on the southern edge of the Great Rann of Kutch (Shekar 1960). Apart from this, Dr. T.J. Roberts quotes Gen. Christon (pers. comm.) having come across a pair at Dalbadin in the Chagai (Pakistan) in 1942.

At the best of times, birds are unpredictable creatures changing their pattern of movement and distribution over a period of time. This fact is proved by the recent records of occurrence of *Hypocolius ampelinus* on both sides of the border between India and Pakistan. Roberts (1992) refers to R. Passburg and himself having observed small parties of this species in the Hab valley (west of Karachi) between February 3 and March 6, 1984. This included a flock of 16 birds on February 17, 1984. Then Asad Ali and R. Passburg saw some numbers in 1986 and 1989 in the same location. But the most significant observation was that of Roberts himself, of 25 to 30 individuals at Zangi Nawar lake in the Chagai desert (Baluchistan) on May 1, 1985; they were going to roost in pairs, behaving excitedly and calling continuously.

S.N. Varu (SNV) accompanied by members of the local nature club was the first person to record the recent occurrence of the hypocolius in Kutch, a male in the vicinity of Chhari Dhandh on January 23, 1990 and one female the same day drinking water at the small village tank of Fulay. During the Bird Migration Study Project undertaken by the Bombay Natural History Society from January 1990 for two years, S. Asad Akhtar and J.K. Tiwari recorded the hypocolius and also captured and ringed a few individuals (details given in the Project Report). From 1992 to 1994, J.K. Tiwari made a more detailed study of the hypocolius at Fulay village under the BNHS Grasslands Ecology Project. The details of occurrences are given in Table 1.

TABLE 1
RECORDS OF *HYPOCOLIUS AMPELINUS* IN KUTCH FROM 1990-94

Location	Date	No. seen	Observed by
Chhari Dhandh	23.i.1990	1	SNV
Fulay village	23.i.1990	1	SNV
Fulay scrub	24.ii.1991	1	JKT
Fulay scrub	25.ii.1991	1	JKT
Fulay scrub	05.iii.1991	6	JKT
Fulay scrub	24.iii.1991	2	JKT
Fulay scrub	03.i.1992	1	JKT
Fulay scrub	13.ii.1993	3	JKT
Fulay scrub	06.iii.1993 (morning)	30	JKT
Fulay scrub	06.iii.1993 (evening)	44	JKT
Fulay scrub	02.iv.1993	4	Muhammad (BNHS local assistant)
Fulay scrub	09.xi.1993	12	JKT
Fulay scrub	12.xii.1993	45	JKT & SNV
Fulay scrub	13.xii.1993	50	JKT
Fulay scrub	20.xii.1993	150	JKT
Fulay scrub	26.xii.1993	4	JKT & MKH
Fulay scrub	27.i.1994	2	JKT
Laija creek (Mandvi)	06.ii.1994	1	JKT
Fulay scrub	10.ii.1994	1	JKT
Fulay scrub	19.3.1994	6	JKT
Fulay scrub	22.3.1994	16	JKT
Fulay scrub	07.iv.1994	1	JKT

The main sightings were made in the area adjacent to Fulay village, having sandy soil with thorny vegetation and ample food supply in the form of berries of *Salvadora persica.* This scrub jungle is situated between Fulay and Chhari villages. It has a dry water course, which runs from Chhari and passes through a greater part of this biotope. The predominant species of vegetation in this area are *Acacia nilotica* and *Salvadora persica. Hypocolius ampelinus* roost in *Acacia* and feed mainly on the ripe berries of *Salvadora*. After their morning activities, these birds, as observed by JKT, would suddenly fly up and disappear, presumably to a source of water.

This species has been seen more recently on various occasions as indicated in Table 2.

TABLE 2
RECENT RECORDS OF *HYPOCOLIUS AMPELINUS* IN KUTCH

Location	Date	No. seen	Observed by
Lakhpat	17.i.1997	1	JKT
Nr. Sindhodi (Abdasa)	1998	1	Kavi Tej
Pingleshwar (coastal dunes, Abdasa)	02.iii.1999	1	Kavi Tej & A. Pomal
Fulay scrub	29.iii.1999	11	JKT & SNV

From the regular sightings and increasing numbers of birds seen fairly regularly for a period of four years, coupled with the recent sightings, though sporadic, it could now safely be inferred that this species has extended its range of distribution and that it is more or less a regular visitor to Kutch. Fresh information from observers in Pakistan about occurrences of *Hypocolius ampelinus* in that country could certainly help us on this side of the border to arrive at more definite conclusions.

The semi-desert type scrub jungle near Fulay, in which the maximum numbers of hypocolius were observed, is in great danger of being cleared for agriculture and if steps are not soon taken to save this biotope, it will be lost for ever. This would also result in the destruction of one more habitat of the pied tit, *Parus nuchalis,* in Kutch, which has already disappeared from some of its former haunts.

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18. COMMENSAL FORAGING RELATIONSHIPS OF THE WHITE-BROWED FANTAIL* *RHIPIDURA AUREOLA* IN MYANMAR

Flocking behaviour of birds in the non-breeding season is widely reported from the tropics. A number of reasons have been proposed for this behaviour. Several authors have observed that birds foraging in flocks benefit from the availability of arthropods flushed by flock mates (Belt 1874, Biddulph 1954, Moynihan 1962, Croxall 1976, MacDonald and Henderson 1977). However, other authors have found little evidence that the so-called "beater effect" (Powell 1985) is an important factor in promoting flocking behaviour (Willis 1972, Powell 1977, Greig-Smith 1978, King and Rappole 2001a).

Fantails are small, fly-catching passerines of the Family Pachycephalidae. Though some species of fantail do not appear to participate in mixed-species flocks, e.g. the Willy wagtail (*Rhipidura leucophrys*) (Cameron 1985) and the yellow-bellied fantail (*R. hypoxantha*) (Stevens 1904), other species of the group, such as the white-browed fantail (*R. aureola*) regularly participate in mixed-species foraging flocks during the non-breeding season. Cameron (1985) reported that grey fantails (*R. fuliginosa*) and rufous fantails (*R. rufifrons*) participating in mixed-species foraging flocks appear to forage on insects flushed by other flock members.

We studied the behaviour and movements of the white-browed fantail in mixed-species flocks in semi-deciduous forest in north central Myanmar, in an attempt to determine the basis for their participation in such groups.

This work is part of a long-term study of the birds of the north-central dry zone of Myanmar initiated in 1994, which is continuing. However, most of these observations were collected from January 16-29, 1999 at Chatthin Wildlife Sanctuary (23° 43' N, 95° 31' E), located roughly 160 km north-northwest of Mandalay in Myanmar's Central Dry Zone. This sanctuary was established in 1941; it covers 268.2 sq. km (Salter and Sayer 1983) in which elevations range from 250-500 m. The climate is characterized by a rainy season (June-October), a cool dry season (November-February), and a hot dry season (March-May). The principal forest habitat at the sanctuary is Indaing, a Dry Deciduous Forest comprised of over 100 tree species, but dominated by *Dipterocarpus tuberculifer*. Indaing has a relatively open understorey of grasses and low shrubs maintained by regular, anthropogenic spring burning in March and April. Dominant trees in the forest lose their leaves in March at the height of the dry season, and leaf out again in June after monsoon arrives, at which time a lush, herbaceous understorey develops (Salter and Sayer 1983, McShea *et al.* 1999, Nay Myo Shwe *et al.* 1999).

Bird flocks were located by walking slowly (*c.* 1.5 km/hr) through the forest, watching for movement and listening for vocalization of common flock associates. Once a flock was located, it was followed as long as possible. Observations were conducted with the aid of 8 x 42 binoculars. Descriptions of the foraging behaviour and movements of flock members were written down or dictated into a hand-held tape recorder for later transcription.

*The white-browed fantail-flycatcher *Rhipidura aureola* is considered a member of Subfamily Rhipidurinae, see *Buceros* Vol 6(1), 2001. Published by: Bombay Natural History Society.

During 253 minutes of flock observation, we observed white-browed fantail foraging commensally with other species in nine instances. In six instances, fantails were observed foraging with flocks of sylviid warblers. In three other instances, fantails were observed foraging with chestnut-bellied nuthatches (*Sitta castanea*) (Table 1).

The general pattern fantails foraging with flocks of sylviid warblers was as follows. The warbler flocks consisted of 3-15 individuals of several species, including plain prinia (*Prinia inornata*), Beavan's prinia (*Prinia rufescens*), Radde's warbler (*Phylloscopus schwarzi*), and common tailorbird (*Orthotomus sutorius*) (King and Rappole 2001a). They generally occur in open Indaing with widely spaced trees and a dense understorey, mainly of grasses and shrubs, *c.* 1 metre in height. Flock members forage mainly in the understorey, and in relatively close proximity to one another (flock diameter <25 m). Fantails foraging in association with these flocks typically perch at the front margin of the advancing flock on an exposed branch or side of a tree trunk 1-2 m above the ground. They hawk flying insect prey, which is apparently flushed by the movements of the flock. As the flock moves through the understorey, fantails shift perches in an apparent effort to keep to a perch that enables them to monitor their flock mates. Warbler flocks, with a fantail in attendance, were followed over distances of up to 300 m. Only once did we see two fantails following the same warbler flock without agonistic interaction. On a separate occasion, a fantail attending a warbler flock was chased back in the direction from which the flock had come by a second fantail, which then assumed sole membership in the flock.

Fantails were also observed attending mixed-species flocks of common woodshrike, small minivet (*Pericrocotus cinnamomeus*), with up to 20 other species, including the chestnut-bellied nuthatch (King and Rappole 2001a). In following these flocks, we observed three occasions when fantails were apparently following the foraging activities of chestnut-bellied nuthatches, and attempting to capture flying insect prey flushed by the nuthatches. In one instance, a fantail was seen with a pair of nuthatches, which were gleaning bark in the canopy. The fantail maintained a position below the pair, making periodic hawking flights into the air below the nuthatches, evidently after invertebrates were dislodged by the nuthatches. The fantail followed the nuthatches as they changed perches seven times in 26 minutes over a distance of 100 m. In another instance, a fantail was seen following a nuthatch through three successive perch changes over a distance of 30 m. As the nuthatch foraged, gleaning invertebrates from tree bark, the fantail kept 1-2 m away from the nuthatch, facing it and evidently observing its activities. Only once did we observe two fantails following the same woodshrike flock without agonistic interaction. However, only one of them was foraging commensally with a nuthatch during that observation.

The members of the Subfamily Rhipidurinae, which include the white-browed fantail, are noted for their distinctive style of foraging, in which the conspicuous white patches in the rectrices are exposed abruptly as the bird fans its tail, either from a perch or in flight, thereby flushing insects which are then captured in flight (Goodwin 1967, Cameron 1985, Recher and Holmes 1985). In Myanmar, we regularly observed fantails perching on tree trunks flashing their outer rectrices and chasing insects flushed from the bark, or making zigzag diving flights over the grass, similar to the behaviours thought by Goodwin (1967) to be directed at flushing insect prey. Thus, the switch from preying on arthropods flushed by the fantail itself to preying on arthropods flushed by other species is a natural one, especially in the case of species that flush or dislodge prey from substrates regularly used by foraging fantails (e.g. grass or bark). Cameron (1985) described grey and rufous fantails

TABLE 1
CIRCUMSTANCES ASSOCIATED WITH OBSERVATIONS OF WHITE-BROWED FANTAIL'S COMMENSALISTIC FORAGING ATTEMPTS

Date	Amount of Time Flock Observed	No. of Fantails Present	No. of Foraging Manoeuvers at flushed or dislodged prey	Distance Fantail Followed Commensal	Commensal Species	No. of Commensals	No. of Other Species
17 January	1132-1142	1	not recorded	not recorded	Beavan's Prinia	5	0
20 January	1020-1130	1	5	40 m	Plain Prinia	7	0
					Common Tailorbird	1	0
23 January	1124-1251	1	5	65 m	Prinia spp.	3	0
23 January	1452-1514	1	not recorded	150 m	Beavan's Prinia	5	
					Raddes' Warbler	3	
24 January	0832-1001	1	8	>200 m	Prinia spp.	10	0
					Raddes' Warbler	5	
27 January	0910-0930	2	2	300 m	Prinia spp.	12	0
27 January	1006-1100	2	3	30 m (3 perches)	Chestnut-bellied Nuthatch	2	5
27 January	1501-1527	1	5	100 m (>5 Perches)	Chestnut-bellied Nuthatch	2	0
28 January	0730-0825	1	1	not recorded	Chestnut-bellied Nuthatch	2	7

following close behind tree creepers (Climacteridae) and warblers (Acanthizidae) and catching insects flushed by these species. We present nine examples of similarly opportunistic foraging on prey flushed by warblers and nuthatches by white-browed fantails.

White-browed fantails appear to forage principally on flying insects, while warblers forage mainly by gleaning sedentary invertebrates from leaves. Thus, it does not appear that warbler flock mates are being interfered with by fantail pursuit of prey that they have dislodged. Nor does it appear that warblers benefit in any way from fantail activities. Therefore, the relationship appears to be commensal, in which one species benefits (i.e. the fantail) while the others are neither helped nor harmed (Odum 1971: 211). The relationship between fantails and chestnut-bellied nuthatches also seems to be mainly commensal, in which the fantail benefits and the nuthatch is not affected. However, nuthatches do, on occasion, pursue dislodged prey as they fall, and in one instance we observed a fantail attempting to steal such prey from a nuthatch. Thus, the relationship between these two species appears to include aspects of kleptoparasitism (Brockman and Barnard 1979).

Benefits of flock attendance in Indaing forest in Myanmar appear to include enhanced predator detection provided by flock mates (King and Rappole 2001a) or opportunities to kleptoparasitize flock mates (King and Rappole 2001b). Our observation of foraging white-browed fantails indicates that this species may regularly benefit from exploiting prey flushed by flock mates, as reported in fantails elsewhere (Cameron 1985).

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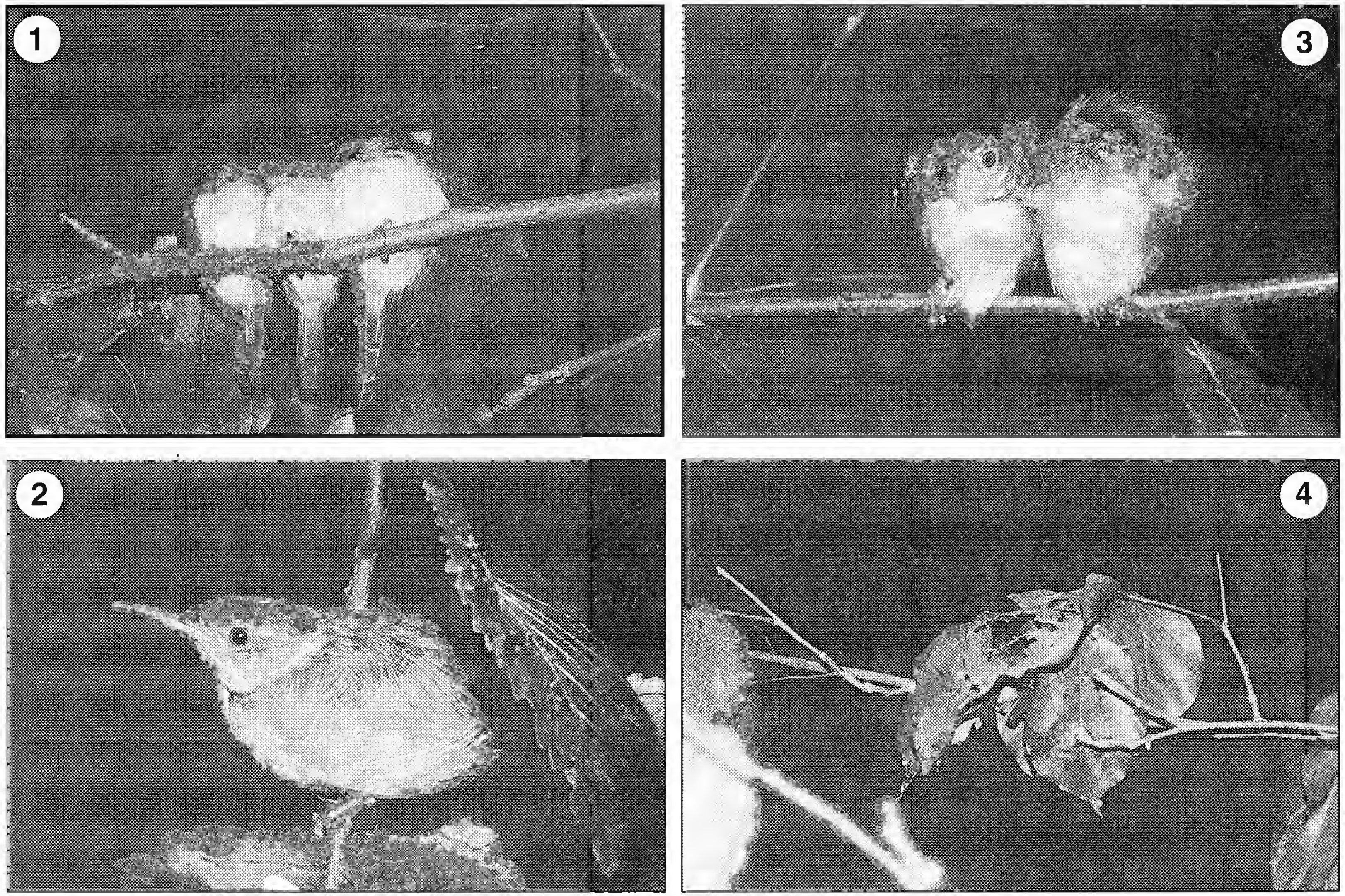
19. ROOSTING BEHAVIOUR OF COMMON TAILORBIRD *ORTHOTOMUS SUTORIUS* (PENNANT)

(*With one plate*)

The common tailorbird *Orthotomus sutorius* (Pennant) is a common warbler found throughout the Indian subcontinent. It uses both natural and artificial fibres to stitch 1-3 leaves to construct a tiny, pocket-sized nest where it lays 2-4 eggs between April and September (Ali and Ripley 1983, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Compact edn, OUP). The nest is generally built close to the ground amidst thick bushes to elude avian predators. Due to the availability of big-leafed garden plants and abundant food comprising of insects and nectar, this highly adaptable bird has colonized almost every medium-sized city garden. Like most diurnal birds, its daytime activities have been studied to some extent. However, there is a dearth of information on its roosting behaviour. In general, the roosting behaviour of gregarious birds is well documented, but that of tiny solitary birds is little understood.

I would like to share my observations on the roosting behaviour of a pair of common tailorbirds in my backyard at Andheri, Mumbai. Though these birds have been roosting in my garden for the past year, I could not find their nest. Since mid-October 1999, a juvenile bird also accompanies the pair, testifying their breeding success this season. Every evening, about 45-60 minutes before sunset, the family arrives in the garden and makes its presence felt through their repetitive "tik-tik-tik-", and not the usual "towit-towit-towit-". At this point, the birds continue their search for insects amongst leaves and bark. Their feeding sorties are interrupted by short preening bouts, which involve face scratching, wing stretching and preening of

Andheria, Anish P. : Common Tailorbird *Orthotomus sutorius* PLATE 1



PICS: ANISH P. ANDHERIA

Fig. 1: A fledgling sandwiched between the parents. The male is easily identifiable by its long tall feathers. Also notice that the heads are tucked behind their shoulders

Fig. 2: An adult bird roosting independently during the non-breeding season, approximately 1.5 m from the ground

Fig. 3: Cuddling behaviour among a pair of common tailorbird during the breeding season, about 1. 5 m from the ground (Plant: *Adhatoda vasica*)

Fig. 4: Roosting site on *Pongamia pinnata* (about 4 m from the ground) after the fledgling began accompanying its parents. The overhead leaves award protection from avian predators, while there is no leaf cover from below. The rear portion of the birds is also visible

various portions of the plumage. In between these seemingly casual activities, they make sallies to the roost for a thorough inspection, where they spend not more than a few seconds.

Finally, after spending about 15-20 minutes in the vicinity of the roost, one of the adults, along with the juvenile, moves towards the roosting site. The birds may give a loud "tik-tik-tik-" in rapid succession just before settling in the roost. This is more pronounced on sensing a cat in the garden (there has always been at least one cat, often two, in our compound). Surprisingly, the presence of the felines has not deterred them from roosting here. The other adult bird, a male (as could be identified from the longish tail feathers) has always been observed to join the other two later (after another 10-15 minutes). During the time he spends alone, he is largely silent, usually engrossed in vigorous preening.

Once in the roost, the three birds become silent and cuddle together i.e. one sandwiched between the other two (Plate 1, Fig. 1). The three birds mostly sit facing the same direction. This, however, is by no means a rule. Interestingly, the juvenile is always in the centre. Here it must be added that before the breeding season, the adults never cuddled together (Plate 1, Fig. 2). They would roost on the same shrub, but on separate twigs. Later, during late August, i.e. after the commencement of the breeding season, the couple was seen cuddling together during the night (Plate 1, Fig. 3). They continued to roost jointly in the beginning of October, while raising a litter in one of the adjoining buildings (nesting site not known). I would like to bring to the notice of the readers that in the past, I have seen similar behaviour among oriental white-eye *Zosterops palpebrosus* and ashy prinia *Prinia socialis*. In both instances, the number of birds involved were three, indicating the presence of a juvenile. Such cuddling behaviour, therefore, seems to be a part of the parental care amongst tiny solitary roosters.

Another interesting analogy can be made between the loud calls of the tailorbirds and the gregarious birds like house sparrows *Passer domesticus* and house crows *Corvus splendens*, which are also very noisy just before occupying their roosts. If disturbed before sunset, they leave the roost giving loud "tik-tik-tik-" calls, but return at the first opportunity. In fact, one evening, though human movement frequently disturbed the birds, they refused to abandon the roost. Each time the birds returned in a few minutes, accompanied by loud alarm calls. The reluctance to evacuate the roost highlights the unwillingness to search for a new site in the fading light.

The roosting site is invariably a thin horizontal branch about 1-4 m from the ground. It always has a few overhanging leaves on the top, forming a roof (Plate 1, Fig. 4), although there may or may not be any foliage at the bottom. This clearly suggests that the birds make concerted efforts at selecting a site that is concealed from nocturnal avian predators, and are not too concerned about predators that are likely to approach from below. In addition to this, protection from heavy downpour during monsoon may also govern such a site selection. Once, for a couple of weeks, they even roosted within a metre from our ground-floor balcony and seemed indifferent to the continual disturbance caused by the lamps. They seem to be using human presence/movement to their advantage, as many predators avoid heavily inhabited areas.

While roosting, they crouch on both legs and tuck their heads over their shoulders (Plate 1, Fig. 1), beneath fluffed feathers. They continue to occupy a particular site for days (20-25) until disturbed or till the leafy roof withers away, a distinct possibility during winter. If bothered during the night, they refuse to abandon the roost even if an interloper actually touches them. This ploy of remaining motionless may be a defence strategy against arboreal reptilian predators that are more sensitive to movement than visual clues. However, they tend

to change the roost on the subsequent night. The newly selected roost is always on another plant, but within the garden. They keep changing the location during the following nights until satisfied with the fresh one.

Other noteworthy observations are:

a) In spite of roosting in close proximity of human habitations, they never use man made structures for the purpose.
b) The adults roosted much closer to the ground, approximately 2 m, whereas after being accompanied by the fledgling the roost was always beyond 3 m, mostly about 4 m from the ground.
c) They tolerate house sparrows at quite a close distance.
d) They refuse to abandon their roost even if they realize that the observer is watching them.
e) Mosquitoes were noticed parasitizing on the sleeping birds.
f) In the morning, the birds leave the roost just before it gets bright i.e. the same time when the house sparrows start getting restless and noisy.
g) Firecrackers had little effect on the birds as they continued to occupy the site during Diwali festival.

From the above observations it is clear that a medium sized tree with low horizontal branches e.g. *Pongamia pinnata*, *Butea monosperma*, *Ficus hispida* or a shrub like *Adhatoda vasica* or *Ixora* sp. is all that is required to attract birds even in crowded cities like Mumbai. Just as it is vital to study the diurnal habits of various fauna, understanding their nocturnal habits, if not more, is equally essential for devising appropriate conservation strategies. The survival of every species is dependent on a proper blend of its adaptation to the geographical cycles of winter and summer, day and night. The common tailorbirds in my garden have accentuated just that.

With the help of the BNHS, I intend to ring these birds in order to monitor their roosting/ breeding behaviour in the coming year.

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20. SIGHT RECORDS OF CRIMSON SUNBIRD *AETHOPYGA SIPARAJA* IN ISLAMABAD, PAKISTAN

The crimson sunbird *Aethopyga siparaja* has been recorded in the Himalayas west to Kangra in Himachal Pradesh (Ripley 1982). During the winters of 1999-2000 and 2000-2001, I observed this species at Islamabad, Pakistan, far to the west of its hitherto known range and the first records for this country, apparently.

The first observation was one juvenile/ eclipse male *Aethopyga siparaja*, seen for about 15 min, at about 15 m range, through 10 x 50 binoculars, at 1000 hrs on December 11, 1999 in an Islamabad garden (Sector G 6/4), feeding from eucalyptus flowers. The bird appeared uniform dark olive-green above, uniform yellowish-olive green below (perhaps slightly more yellow towards the belly), with a dull reddish-pink chin and throat (not extending to breast). No evident eyebrow, and dark eye prominent on an otherwise plain face. No ashy or grey tinge on either upperparts or underparts. No yellow was noticed on the rump, nor any white tips to tail feathers, which was short and

square-cut with no graduation. The bill appeared longer and more prominent than in Mrs. Gould's sunbird *Aethopyga gouldiae*. The bird called often, a short "tzip". In spite of keeping a lookout, it was not seen again in the winter of 1999-2000.

I identified this bird as a juvenile male *Aethopyga siparaja*, based primarily on (i) the reddish throat, which I believe is not shown by any other South Asian *Aethopyga* in either female, juvenile or eclipse plumage; (ii) lack of any grey tinge above or below, uniform yellowish-green underparts and no noticeable yellow on the rump, which excludes A. *gouldiae* and *A. saturata*; (iii) lack of prominent white tips to tail feathers, which excludes *A. gouldiae* and *A. nipalensis*; and square-cut, not graduated tail, which excludes *A. nipalensis*. Female/juvenile male *A. ignicauda*, in my experience, usually shows some orange or red in the tail.

The species reappeared in winter 2000-2001 in the same locality, with at least four individuals present in the area. It was first seen on January 3, 2001, one juvenile/eclipse male similar to the 1999 bird. Between then and February 4, four different birds were seen, one long tailed male; one juvenile/eclipse male showing extensive bright red chin, throat and 'shoulders' (lesser wing coverts); another juvenile/eclipse male (the first one mentioned above) with duller red chin and throat and no red on 'shoulders'; and a female, with uniform yellowish-olive underparts and no red at all. Twos or singles were seen frequently through February, then less frequently in March with my last record (an adult long-tailed male) on March 26, 2001. Some mutual antagonism (territorial? sexual?) was noted on several occasions, e.g. one bird flying out, calling in flight, to chase another that appeared nearby. The birds were active throughout the winter day, and were seen feeding on remnant flowers of bottlebrush *Callistemon*, and *Eucalyptus*, and catching insects in flight. They were quite vocal, and apart from the distinctive "tzip", also called "tzip-ip-ip" or "chit-chit-chwe". A subdued song (subsong?) was heard on a couple of occasions, prolonged and continuous over two or three minutes, comprising a mixture of the rapidly repeated call notes alternated with short bouts of warbling or chirruping, rather sparrow-like in tone and character.

On January 25, three birds — the long tailed male, the juvenile/eclipse male with red shoulders and the female — were together in a leafless *Broussonetia papyrifera* (introduced paper mulberry) tree with the two males showing apparent antagonistic behaviour towards each other, cocking their tails, raising their beaks to show off the scarlet on their chests and 'singing' at each other. Seen through binoculars at close range (under 10 m), the long-tailed male was noted to be in moult. The chin, throat and breast were largely bright scarlet, but some olive-green feathers remained on either side of the lower throat and sides of face, and the mantle showed an admixture of crimson and green feathers. The purple malar stripes had developed, and the yellow rump was visible when the bird cocked its tail. Tail moult appeared complete, with fresh iridescent green central tail feathers, and iridescent green patches were visible on the forecrown. Similarly, the short tailed juvenile/eclipse male with red 'shoulders' also showed a few iridescent green feathers on the forecrown and scarlet patches on the sides of the breast. By mid-February, both these features were much more pronounced and extensive, but the tail was still short. Seen again closely on March 11, a long-tailed male had apparently completed moult and was in fine plumage.

I am familiar with all five South Asian *Aethopyga* sunbird species, in India, Nepal and Bhutan. The observations in 2001 confirm the identification of the species beyond doubt.

Mrs. Gould's sunbird *Aethopyga gouldiae*, which normally occurs west to the Sutlej Valley in Himachal Pradesh, has appeared as a wanderer in winter in the Islamabad neighbourhood

(Roberts 1992). The only other sunbird species recorded in Pakistan is the purple sunbird *Nectarinia asiatica*, a summer visitor to the Islamabad area. It had arrived in Islamabad by early March 2001, and for almost three weeks, both species could be seen in the same general area. No mutual interaction was noted between the two species. As far as I am aware, there are no previous records of the crimson sunbird from Pakistan.

Seasonal movements of nectar-feeding birds have been recorded in literature, and the wandering of *A. gouldiae* far to the west of its usual range is probably explainable by the paucity of flowering plants in winter in the western Himalayan foothills. Islamabad, with its large variety of planted exotics, may be attractive to nectar-feeders for this reason. But the records of *A. siparaja* over two winters in Islamabad may indicate that the species has begun to winter regularly in the area, and possibly even have expanded its breeding range to the adjacent Margalla ravines or Murree foothills where suitable habitat is certainly available.

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21. FOLIAGE-DEW BATHING IN ORIENTAL WHITE-EYE *ZOSTEROPS PALPEBROSUS*, FAMILY ZOSTEROPIDAE

Birds have been seen to employ a variety of methods for body-maintenance including bathing and anting. Bathing is defined as any of a variety of stereotyped movements by birds to wet (and/or dust) their feathers (Ehrlich *et al.* 1994). Bathing is a common phenomenon and is believed to help allay itching, remove parasites and clean feathers, which require considerably more care than hair or skin, due to their structural complexity and importance for birds (Welty and Baptista 1988). Birds have been seen to bathe in dust, snow, sunlight, rain and water. In passerines, bathing is characteristically hurried, with continuous movement, usually in water and rain (Welty and Baptista 1988). Five types of bathing have been listed for passerines: i. splashing while standing in shallow water, ii. hopping in and out of water, iii. dipping down from flight (into stagnant or moving water) thus splashing water over their moving body, iv. bathing in the rain and lastly, v. shuffling about amongst wet vegetation (Freethy 1982). The last type seems to be rare and we report our observation on the oriental white-eye *Zosterops palpebrosus* (Temminck) indulging in this kind of bathing.

At the Forest Research Institute, Dehra Dun, November 1999, we observed a flock of about 25 oriental white-eyes bathing in the moisture on vegetation at 0900 hrs. In November, night temperature falls to nearly 10 °C and, in the mornings, much of the vegetation is covered with dew. The birds were seen to rush into the top-most branches of small-leafed shrubs by turn. They would brush vigorously against the vegetation to make the water fall upon them, and go into bouts of vigorous shaking accompanied

by continuous, rapid opening and closing of wings. Each bird took an average of two seconds (range: 1-4 seconds). It was not clear if an individual bird repeated bathing or whether it was always a different individual bathing. Following the bath, which we have termed "foliage-dew bathing" the birds preened themselves briefly before resuming foraging. White-eyes are known to be mainly arboreal although they have been seen to fly down to bathe in 'runnels' (Ali and Ripley 1974), they have not been seen to foliage-dew bathe.

Most forms of body maintenance behaviour are thought to be inborn in birds. Young goshawks have been seen to go through bathing movements on bare ground on seeing a brood mate splashing in water (Bond 1942), and hand-reared motmots have been observed to go through bathing movements, at the mere sound of rainfall (Smith 1977). Since dew is available only a few months in the year, this form of bathing is prevalent only in those months. We have observed white-eye in other parts of Dehra Dun and India, and questioned other bird watchers, but have not encountered this behaviour elsewhere and the behaviour is rare in the species. The habit could have been learnt either by accident or by watching other species of birds foliage-dew bathing. It is possible that the behaviour is peculiar to a small local population wherein the young ones learned by watching older birds. In the case of North American wren-tits *Chamaea fasciata*, which wet their feathers from dew on vegetation, this is thought to be an adaptation to an environment where water is scarce (Ehrlich *et al.* 1994). If this is true for all birds which foliage-dew bathe, only dew is likely to be used, and never rain water on leaves, since water is plentiful on the ground during the rainy season. Hence, the term foliage-dew bathing would be far more appropriate than foliage-moisture bathing, which would encompass all sources of moisture on foliage, including rain.

It was particularly interesting to note that the oriental white-eye maximized the use of water falling from leaves by choosing small-leafed plants, in spite of dew being present on larger leaves. Water falling from a cluster of smaller leaves tends to have a large number of smaller droplets, as each leaf cannot accumulate enough water to form large drops. The cluster also covers a larger area underneath. In contrast, a single large leaf, when shaken, forms fewer numbers of larger drops that have to be "caught" properly to be useful to the bird for bathing. It was unclear why they chose the top-most branches all the time.

We thank R. Jayapal for going through the manuscript and giving helpful suggestions to improve it.

February 23, 2000

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22. FOOD HABITS OF THE BAYA WEAVER *PLOCEUS PHILIPPINUS* (LINN.)

(*With one plate*)

The baya weaver *Ploceus philippinus* (Linn.) is known to feed on food grains, caterpillars, small insects, moths, spiders, orthopterous insects, grass and weed seeds (Ali, S. 1945, THE BIRDS OF KUTCH, pp. 42-43, OUP; Roberts, T.J. 1992, THE BIRDS OF PAKISTAN, Vol. 2, pp. 493-496, OUP). Weaverbirds are known to exploit fallen grains and raid standing crops. However, in Kerala State, southern India, George reported several baya weaver catching frogs in a rice field and eating them. (*JBHNS*, Vol. 70, 1973).

Harshad Pomal, a nature photographer from Bhuj, photographed (Plate 1) a baya weaver feeding on a gecko. The female carried the gecko to the nest to feed her young ones. He observed this at Khari river area near Bhuj. This appears to be a new item in the food list of the baya weaver and hence worth reporting.

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23. FOUR NEW BIRD RECORDS FOR SINDH, PAKISTAN

Ever since moving into our home in Karachi in March 1994, which is in Dhoraji adjacent to a small park, there has been a single magpie (*Pica pica*) around the park. It has occasionally not been sighted for up to a week, but has always reappeared. It tends to frequent with house crows (which sometimes mob it). About two weeks ago, I last saw the bird looking less pristine than usual, and tending to hide in bushes, and I have not seen it since — I fear it may have died. In any event, it was here for over five years. The nearest part of the species' normal range is in central Baluchistan. It is unclear if it is a genuine wild bird that strayed here, or an escape, though I am not aware of the bird being kept caged.

On May 31, 1998, while experimenting with a newly acquired adaptor on my Kowa spotting telescope, I photographed a single spotted munia (*Lonchura punctulata*) in an acacia bush in the adjacent park in Karachi (Kidney Hill Park). T.J. Roberts (1992, BIRDS OF PAKISTAN) reports the bird as being confined to northern Pakistan. To my knowledge, there is no previous record in Sindh. Tom Roberts suggests that this could have been an escape, and that possibility cannot be excluded.

On June 28, 1998 at Gizri Creek in Karachi (between the Defence and Korangi areas) I saw and photographed a woodchat shrike (*Lanius senator*) — a bird I am familiar with from southern France. This bird was present for about 4 hours in the morning, but was not seen on subsequent visits. Roberts does not include the species in his BIRDS OF PAKISTAN, but Ali and Ripley (1996) in their PICTORIAL GUIDE TO THE BIRDS OF THE INDIAN SUBCONTINENT mention an unconfirmed record from Quetta, Baluchistan. Since the species nests in Iran, it is not an entirely unexpected occurrence. Alas, Gizri creek is no longer the excellent bird habitat of old, as the creek bed has been reclaimed by filling it with sand, presumably for future buildings.

On October 18, 1998, on the Hub River, which separates Sindh and Baluchistan, about 45 km northwest of Karachi and about 2.5 km upstream from the upper tidal limit, I saw and photographed a black-capped kingfisher (*Halcyon pileata*). It flew across the river several

Varu, S.N.: Baya weaver *Ploceus philippinus* PLATE 1

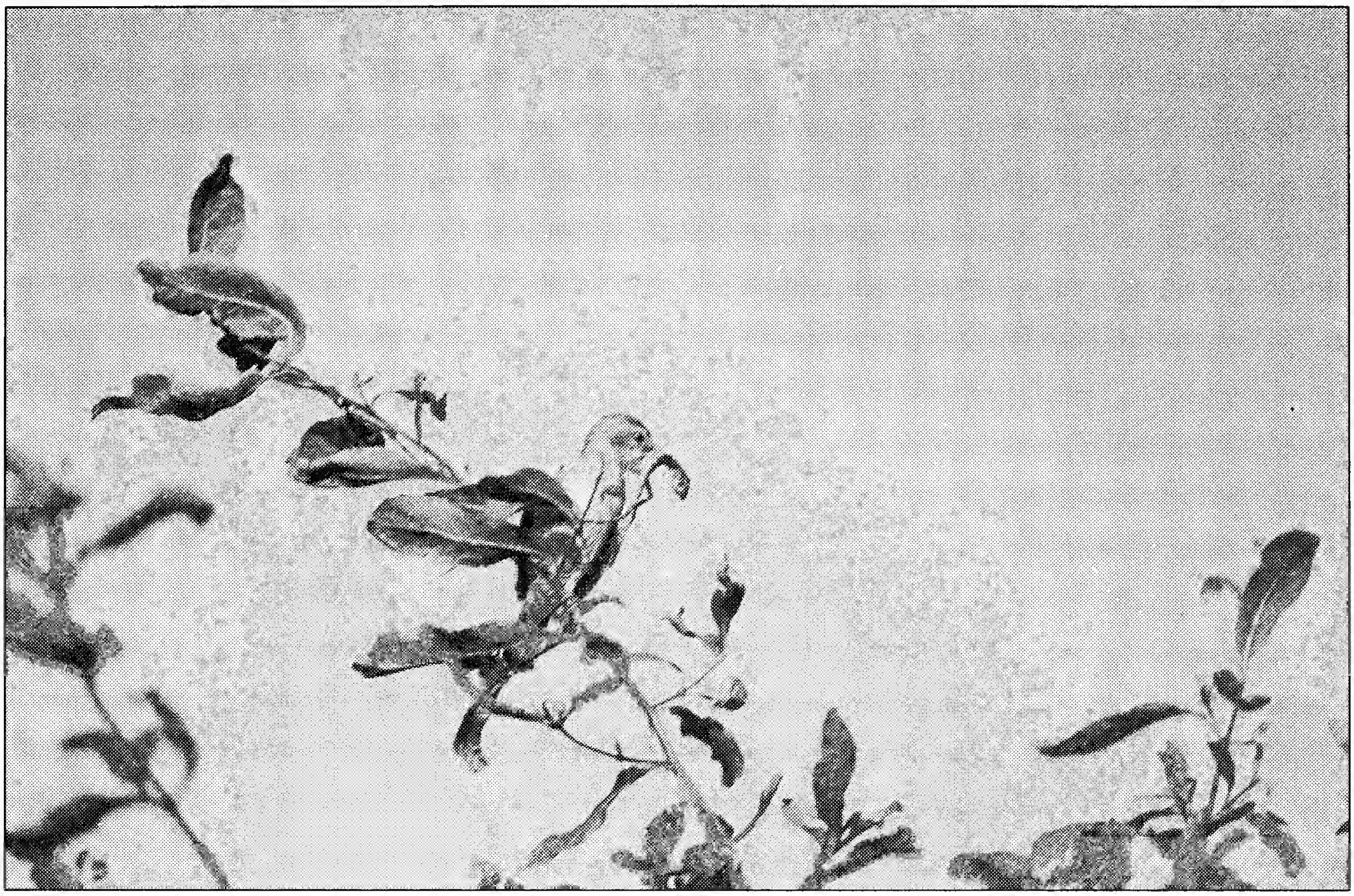

Fig. 1: Baya weaver *Ploceus philippinus* feeding on a gecko

times, and was therefore seen in both Sindh and Baluchistan. The bird was seen again one week later (October 25) by my wife and my driver, but was not present on subsequent visits. Roberts does not include it in his book, but he and others tell me that it has been seen and reported on at least one previous occasion in Pakistan, by a bird watcher from Finland, I believe, who was resident in Islamabad for some years.

Eds: The author has photographic evidence of all the sightings.

February 23, 2000

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24. ADDITIONS TO THE CHECKLIST OF THE BIRDS OF PAKISTAN, VOL. 1 NON-PASSERIFORMES, VOL. 2 PASSERIFORMES

In these volumes published by Oxford University Press, Karachi in 1991 and 1992 respectively, I attempted to set out what was currently known about the status of birds recorded within the political boundaries of modern Pakistan, including a baseline checklist totaling 663 species.

Since that time nine, if not ten, additional species have been recorded and in the majority of instances, these records have been published by the observers. As the author of the above volumes, I feel that it is desirable to gather together these scattered records and to give them wider publicity, especially as some of them could be new subcontinental records.

1. **Eurasian Dotterel *Eudromias morinellus***

In the *Buceros* Vol. 3, No. 2 , 1998, titled "Standardised English Names of the Birds of the Indian Subcontinent - A Proposal", the common dotterel is omitted, presumably because the panel of experts did not know of, or did not accept, the inclusion of this species in "An Annotated Checklist of the Birds of the Oriental Region", by Inskipp, Lindsey and Duckworth (1996), though the Editors of that *Buceros* issue state that they are following the taxonomic sequence of that Checklist. Since Inskipp *et al.* do not give any distributional data for inclusion of the common dotterel, our Pakistan record is important. In January 1991, a Swedish ornithologist and long-time resident in Karachi, visited the Hab Valley along the border between Sindh and Baluchistan Provinces, in an arid mountainous region with savannah vegetation and a large dam-reservoir. He and his wife were alone, but spotted a winter plumage common dotterel, which Rolf Passburg photographed. This photograph was subsequently enlarged and widely exhibited in November 1991 during the visit of the Duke of Edinburgh to Pakistan, in his capacity as President of WWF International. The new record attracted widespread interest at that time. Compared with other similar plumaged plovers, the dotterel has a distinctive broad creamy white supercilium extending around to the nape, as well as a thinner creamy white band separating the "dirty" buff upper breast and throat from the paler buff lower breast. Passburg wrote to the Oriental Bird Club (OBC) about this record, but without sending the photograph, and for some reason OBC refused to accept it. Rolf has kindly promised to send me a copy of this photo, which I shall, in due course, deposit with the Picture Library of the BNHS.

2. **Black-capped Kingfisher *Halcyon pileata***

A single individual frequented the mangrove creeks just west of Karachi in January 1995, and this new record was published by Juha

Kylänpää in *Forktail*, Vol. 13, 1998. p. 126. In October 1998, another individual was photographed by Dr. Roger Sutton in the Hab Valley, close to the site where the dotterel was seen. Dr. Sutton kindly gave me copies of several of his photographs, and he has submitted a paper to the Oriental Bird Club on this and other sightings (In press).

3. **Oriental Tree Pipit *Anthus hodgsoni***

A party of 5 ornithologists visited Pakistan for a faunal survey under the Himalayan Jungle Project, which focused on the best remaining population of the western tragopan. While dealing with officialdom in Islamabad, they recorded all the birds in that area, which is very rich in both flora and animal wildlife. In scattered forest on the banks of the Rawal Lake, they observed a party of 15 oriental tree pipits from January 29 to February 4, 1996. Their record was published in official reports to several sponsoring agencies, including BirdLife International, WWF International and the World Pheasant Association. They cited my exclusion of this pipit in Volume 2 of Birds of Pakistan.

4. **Redwing *Turdus iliacus***

In February 1989, Juha Kylänpää, a Finnish Missionary, picked up the decomposed body of a thrush in his compound in Tonk, in Dera Ismail Khan, NWFP. He sent the wings to a museum in Finland, where they confirmed that it was a redwing. After much time and correspondence, Juha sent one wing to me and I was able to deposit this wing in the collection of the Bombay Natural History Society.

5. **Woodchat Shrike *Lanius senator***

Undoubtedly a new subcontinental record. Again it was Dr. Roger Sutton who discovered this individual, frequenting thorn scrub along the banks of Ghizri Creek, just on the southeastern outskirts of Karachi. I have several copies of clear photographs which he took of this bird, which was seen in late June 1998.

6. **Common Reed Warbler *Acrocephalus scirpaceus***

The Finnish diplomat, Mikko Pyhälää made a number of valuable contributions to the ornithology of Islamabad region, during his posting to that capital city. During a visit to the Sindh Province in Larkana district, he observed three specimens of the reed warbler at Harnal Lake (27° 23' N; 67° 55' E) in *Phragmites* reeds, where he was able to compare it with *A. stentorius* and *A. agricola*, all three of which were seen in the same small area. He published this record of sighting the birds on January 12th 1996, in the first edition of the newly established *Pakistan Journal of Ornithology*. As published, he observed them at close range with binoculars and telescope, and noted the pale supercilium only in front of the eye in *A. scirpaceus*, the noticeably smaller size and less vociferous song of *A. scirpaceus* compared with *A. stentorius*. Blyth's reed warbler *A. dumetorum* is only reliably separable in the hand (wing formula), but in Pakistan this species always stays in low bushes and trees in dry land areas and is not found in water emergent *Phragmites*. *A. scirpaceus* being such a difficult bird to observe, and known to breed in Iran and to winter in Afghanistan, its occurrence this far to the East is not surprising. Dr. Aleem Ahmad Khan, OBC's representative for Pakistan, also told Pyhälää that he had seen this species, but unfortunately I do not have details and Miko Pyhälää is now serving in South America!

7. **Little Bunting *Emberiza pusilla***

Rafiq Ahmad Rajpoot, at the time a junior Field Officer working for the Sindh Wildlife Board, visited the Karchat Information and Conservation Centre in the south western corner of the Kirthar National Park in Sindh. During a survey from October 24 to November 11, 1992, he recorded 120 different bird species, including

three little buntings, which were drinking from a small seepage zone, in this dry hilly area. I know Rajpoot personally and he is a keen birdwatcher, with a good knowledge of reptiles and mammals as well. All the other species recorded in his Karchat list had been previously recorded there. Rajpoot did not have a camera; his observations were not substantiated by any other companion, and have not been submitted for publication. All the known records of this uncommon wintering visitor to the Subcontinent have been in the far northern areas of the Himalayas. His report and lists of species are deposited in the Sindh Wildlife Board Library, open to the public. However, the record should be treated with caution and probably should not be included in a definitive Checklist.

8. **Indian Pied Hornbill** ***Anthracoceros malabaricus***

Seen on March 13, 1999 in Mirpur, in Poonch by Major Erkki Kallio. This was in the area presently on the Pakistan held side of the Cease-fire line.

9. **Long-tailed Broadbill** ***Psarisomus dalhousiae***

Seen on August 21, 1999 by Major Erkki Kallio at Kotli in Poonch, presently on the Pakistan held side of the Cease-fire line.

Both these records i.e. the Indian pied hornbill and long-tailed broadbill, are of interest in that they must be the westernmost record for these species from the Himlayas.

10. **European Robin** ***Erithacus rubecula***

Seen on February 13, 2000 in Islamabad at the foot of the Margalla Hills. A second European robin seen by Juha Kylänpää in Kao forest below Dunga Gali, Hazara district on December 28, 2000. Major Erkki Kallio, a keen and reputed birdwatcher in his own country, was working with UNMOGIP as a Military Observer, and based in Islamabad at the time, and Juha Kylänpää is a missionary based in the NWFP, who has already published two articles of his bird sightings in Pakistan, in the Journal of the Oriental Bird Club, *Forktail* and he was the individual who picked up a wing of the redwing *Turdus illiacus* deposited by me in the BNHS Collection, as mentioned above. I was so surprised at the robin sightings that Major Kallio kindly sent me a slide that he took of the bird, and there is no mistaking his identification. I understand from him that it has also been recorded in India for the first time in 1999 at Rajouri, also in Poonch, and this information was passed on by Erkki to the Indian Deputy High Commissioner Sudhir Vyas in Islamabad, who also writes in the *JBNHS*.

I think it is important to record unusual distributional records where they represent extensions of known range. Sadly, so often there is shrinking of range of so many species, and in the case of the European robin it is not normally considered a long distance migrant.

February 23, 2000

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25. SOME INTERESTING BIRD RECORDS FROM THE DELHI AREA

A four-year posting at Delhi from mid-1995 to mid-1999 provided me with an opportunity to review the bird life in the area, and compare it with notes made during earlier periods of stay in 1977-79 and 1984-86 (Vyas 1995). In ten years, the city of Delhi has grown phenomenally, particularly to the east and south, and some of the most fruitful birding localities no longer exist. The formerly bird-rich marshes near the Coronation Pillar and Model Town in north Delhi have been drained and built upon. Large areas of reed beds about 5 km south of

Okhla along the Agra canal near Madanpur village, which were a known locality near Delhi for species such as ruddy-breasted crake *Porzana fusca*, are now badly degraded, encroached upon and partially covered by landfills. Sultanpur Lake near Gurgaon, located 48 km south-west of Delhi, was dry during the winters of 1997-98 and 1998-99, depriving the area of one of its most productive sites. Increased cultivation and construction in the neighbourhood of Sultanpur Lake, and the drainage of marshes and seasonal inundations in the surrounding area, has also reduced its attractiveness for birds. On the other hand, the pond area of the new Okhla Barrage (now Okhla Barrage Bird Sanctuary) has emerged as an excellent new site, attracting a number of water and marsh species, in spite of the extremely high level of water pollution. The bird habitats of Okhla Barrage have been described by Urfi (1993). For other sites referred to in this note Ganguli (1975) provides a general reference.

The following are new or interesting records for the Delhi area, and some notes on bird population trends made during this period.

Yellow bittern *Ixobrychus sinensis*, Chestnut bittern *Ixobrychus cinnamomeus* and Black bittern *Dupetor flavicollis*: All appear to have increased considerably in the Delhi area compared to the 1980s. The expansion of reedbed habitats in the Okhla reservoir area consequent to the construction of the Okhla Barrage is a likely reason. Yellow and chestnut bitterns were found common and breeding (juveniles seen) at Okhla between May 4 and end August. Black bitterns also appeared at Okhla from early May, and one was recorded as late as October 12, 1997 in reed beds near Madanpur.

Great bittern *Botaurus stellaris*: One bird was flushed from a reedbed at Sultanpur on December 25, 1996. There are old 19th century hunting records from about Delhi [Anon (= Editors) 1949], but I know of no subsequent mention for Delhi specifically.

Glossy ibis *Plegadis falcinellus*: Formerly recorded irregularly about Delhi (Hutson 1954, Ganguli 1975), but it was not noted in the 1970s and 1980s. It seems to have reappeared, with about 25 present at Sultanpur in the winters of 1995-96 and 1996-97. The lake was dry in winter 1997-98.

Bar-headed goose *Anser indicus*: Numbers appear to have fallen considerably in the Delhi area over the last ten years. Compared to a minimum of 1,500-2,000 at Sultanpur in winter 1985-86, numbers both at Sultanpur and Okhla did not exceed 10 in the winters of 1995-96, 96-97 and 97-98.

Common shelduck *Tadorna tadorna*: Unlike earlier, this species was regularly recorded during the observation period at Okhla in winter, with 11 through December 1995, 12 on March 16, 1997 and 14 through February 1998.

Greater scaup *Aythya marila*: At least two birds, one male in breeding plumage and one female, were part of a mixed gathering of about 4,000 other duck, including common pochards *Aythya ferina*, tufted pochards *Aythya fuligula* and red-crested pochards *Rhodonessa rufina* at Okhla Barrage on February 22, 1998. This species has been listed for Delhi by Ali and Ripley (1968) and, Abdulali and Pandey (1978), but is not mentioned by Ganguli (1975).

Besra sparrowhawk *Accipiter virgatus*: One bird was observed a little after noon on December 30, 1997 in a thickly wooded patch in the Delhi Zoological Park. The bird flew into the canopy of a large tree where it perched; turning occasionally to ward off attacks by mobbing house crows *Corvus splendens*. Thus, I could observe the bird well for about five minutes, at about 20 m range with 10 x 50 binoculars. It appeared about the same size or slightly smaller than the shikra *Accipiter badius* and (i) dark brownish-slaty above, darker and much less clear grey than shikra, no pale eyebrow; (ii) noticeably square-cut, brownish-

grey tail with three broad dark bars running across (including the central tail feathers), very conspicuous; (iii) dark grey cheeks contrasting in a clear line with a whitish throat, which showed a clear, broad, dark, mesial stripe and a few dark brown streaks in a restricted band on the lower throat; (iv) entire breast and belly barred broadly with rufous (much more coarsely than is usual in shikra), with each rufous bar somewhat wavy and edged with a thin dark line above and below; thigh feathers also barred, but the bars narrower and browner, (v) eyes pale yellow, cere greyish, not contrastingly noticeable, legs yellow. It did not show a reddish shield on the breast. This bird is definitely not *Accipiter nisus* or *badius*, and, on the basis of the characters above, I identify it as a besra sparrowhawk, probably a female bird. Through December 1997, much of northern India including Delhi had an extended spell of cold and very foggy weather, which may explain the presence of this bird out of its usual range. I do not know of any earlier record of besra sparrowhawk from the Delhi area.

Eurasian hobby *Falco subbuteo*: There are very few records of this species from Delhi. One was hunting over trees in the evening in central New Delhi on September 21, 1997.

Other, more generalized comments on birds of prey populations about Delhi may be made. These are based on a subjective comparison with my own records in the 1970s and 1980s (Vyas 1995). There has been a striking decline in the numbers of *Aquila* eagles wintering about Delhi. I had no records of the eastern Imperial *A. heliaca* or tawny eagles *A. rapax* in the years 1995-1998. Steppe eagles *A. nipalensis* are now scarce in Delhi's immediate vicinity, whereas up to the 1980s they were a feature of the riverain tract along the Jamuna river. While spotted eagles *A. clanga* still appeared in small numbers about Okhla and Sultanpur, I had no records of Pallas' fish-eagle *Haliaeetus leucoryphus* or osprey *Pandion haliaetus* in the 1990s. Similarly, there were no records of laggar *Falco jugger*, though single red-headed falcons *Falco chicquera* appeared in February and July 1998 at Okhla and Sultanpur respectively. The number of Indian white-backed vultures *Gyps benghalensis* has fallen dramatically, in keeping with trends reported widely from elsewhere in India (Rahmani 1998). This decline was evident even between 1996 and 1999, and several occupied nests within city limits in New Delhi were abandoned. The species bred commonly in the city earlier, but in 1999, I could count just three occupied nests on roadside trees in a restricted residential area in New Delhi, compared to 18 in this area in 1996.

Demoiselle crane *Grus virgo*: There are not many records from Delhi, and usually of small numbers. Two flocks, of about 80 and 26 birds respectively, were seen at Okhla in the morning of September 29, 1996, flying in from the east and then turning north along the river. The number of common crane *Grus grus* has dropped sharply. While a few hundred used to winter regularly about Sultanpur in the 1970s and 1980s, I recorded only three during the current period at Sultanpur on December 26, 1996.

Watercock *Gallicrex cinerea*: Its earlier recorded locality in the area, the marshes near the Coronation Pillar in north Delhi, no longer exists. Instead, watercocks (mostly males in breeding plumage, but also females) were recorded quite commonly, and almost certainly breeding, at Okhla between June 22 through August each year from 1996 to 1998. Their numbers have increased, with up to five individual males seen foraging separately one evening. Birds were noted flying around in the evenings in June and early July, and dropping into marsh; often seen feeding in open grassy patches in the mornings and evenings.

White-winged black tern *Chlidonias leucopterus*: The species has occasionally been seen in breeding plumage about Delhi in May-June (Ganguli 1975, Vyas 1995). On October 20,

1996, there was at least one with a scattered flock of whiskered terns *Chlidonias hybridus* at Okhla in (first) winter plumage; on August 30, 1997, there were three with whiskered terns and gull-billed terns *Gelochelidon nilotica* over flooded fields near Madanpur village. All showed the characteristic head pattern (black eye patch clearly separated from black nape, no streaking on crown), noticeably smaller bills, whitish-grey rumps and absence of any dark patches on side of breast. On the latter occasion, one bird had the solid brown mantle of the juvenile white-winged. Their flight action was slightly quicker, with deeper wing beats, than nearby whiskered terns which offered opportunities for direct comparison. It may well turn out to be a regular, but overlooked, autumn passage migrant.

Black tern *Chlidonias niger*: On September 28, 1998, two *Chlidonias* terns at the Okhla Barrage were noted flying together, quartering an area of shallow water along the bank with abundant submerged weeds, in close proximity to but separate from large numbers of whiskered terns which were mostly in winter plumage or moulting from juvenile to first winter plumage. They were observed with 10 x 50 binoculars, at times as close as 15 m range. Attention was first attracted to them because of their head pattern, strikingly different from the extensively streaked crown, framed below by a black line behind the eyes and around the nape, of the whiskered terns. These two birds showed (i) a solid black "skull-cap" contiguous with a broad black eye patch curving back and down from each eye; (ii) grey mantle with a few dark brown feather edges on the lower scapulars; (iii) no marked pattern on the wings; (iv) pale grey rump and tail, the latter with an admixture of white towards the bases of the feathers; (v) white underparts with very noticeable dark grey patches on sides of breast; on one bird the side patches were extensive (extending quite far down into the white breast), smudgy and medium-grey, and on the other, they were smaller, more sharply defined and darker grey; (vi) smaller bills compared to whiskered terns nearby; (vii) no difference could be noted in flight action. I have seen black terns in winter plumage (outside India) earlier, and, after consulting available literature, I am convinced of my identification of these two birds as black terns, moulting out of juvenile into first-winter plumage. The species has been recorded once for Delhi by H.W. Alexander (Hutson 1954, Ali and Ripley 1969).

Indian plaintive cuckoo *Cacomantis passerinus*: Vocal, and seen about Okhla, Gurgaon and Sultanpur from late-May/June onwards through 1996-1998. Quite common, as three calling males were recorded over a 2 km transect along the river, south of Okhla on June 1, 1997. Although there are earlier scattered records, this cuckoo now appears to have established itself about Delhi as a regular summer/monsoon breeding visitor. I had neither seen nor heard this species in Delhi in the 1970s and 1980s.

Bengal bush-lark *Mirafra assamica* (race *assamica*): This species is not listed for Delhi in the earlier checklists, and may be a new arrival in the area with the creation of suitable habitat due to the formation of the Okhla Barrage. It was present and probably breeding through 1996-98 at Okhla and Madanpur, in overgrown fallow fields adjacent to marshy depressions and borrow-pits. The birds were tame, and afforded frequent opportunities for close observation when they fed along earth-tracks. It was noted between early March and October 12, and may possibly be a year-round resident, though it was not seen in winter. Persistent song and display flights in the mornings between March 16 - August 17, with a maximum of three displaying birds (presumed to be males) and at least one more present at Okhla, one bird still singing and suspected nesting (dropping into grass repeatedly at the same spot) on August 17, 1997. One was seen at Madanpur on October 12, 1997.

Attention was first attracted to the bird by

its different song flight compared to little eastern skylarks *Alauda gulgula* displaying in the same area. It is very different also compared to that of red-winged bush-larks *Mirafra erythroptera*, which are not in this habitat. The bird soared fairly high in the air, alternately fluttering a little way up and then gliding a little way down with wings in a V, tail partly fanned and legs hanging loose all the time, thus executing a continuous series of short shallow dips or scallops in the air; this continued for several minutes before gliding down to the ground. A high-pitched, rather hoarse, thin, song accompanied each dip, each phrase sounding like "i'eezz" of less than one second duration. The birds displayed almost continuously in the morning, at least till 1030 hrs. I would like to point out that this song flight does not match that described for this species in Ali and Ripley (1972), but is closer to the description in Alstrom (1998).

Common raven *Corvus corax*: Two birds were seen at the Buddha Jayanti Gardens, New Delhi Ridge, on March 20, 1996. One, chased by a house crow, soared up to circle and soar with a group of Egyptian vultures *Neophron percnopterus*, another flew across the gardens to perch in a leafless silk-cotton tree, where it was studied through binoculars from about 25 m, at about 0930 hrs in bright light. A house crow mobbed it, offering direct comparison of size. The bird appeared almost twice the size of the house crow, the size difference evident both in flight and at rest; broad wedge- shaped tail noticeable even at rest; massive beak, not heavily bowed as a jungle crow's; forehead not steeply rising from the bill as in a jungle crow; highly glossy plumage; throat hackles visible, but not protruding; stately flight, with slower wing-beats than house crow; and its soaring silhouette were all distinctive. The birds did not call. I have never recorded soaring behaviour in house crows, or the jungle crows *Corvus macrorhynchos* that turn up occasionally about Delhi. There have been only a few old records from the Delhi area, where it was considered as rare or vagrant (Ali and Ripley 1972, Ganguli 1975).

Bristled grass-warbler *Chaetornis striatus*: I recorded at least 5 birds (including 3 singing and displaying males) in areas of waterlogged grass and reeds, and in a reed-covered borrow-pit at Okhla, between August 4 and mid-September 1996. The birds were seen by several members of the Delhi Bird Club, photographed and reported to the Oriental Bird Club (Grewal 1996). In 1997, there were none at Okhla - there had been massive disturbance of the reedbeds due to malaria control operations - but at least one displaying and calling bird was present in reedbeds near Madanpur in August 1997. There was no evidence of its presence in 1998. I can trace only one earlier record from Delhi, in 1962 (Donahue 1967).

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26. THE GHARIAL *GAVIALIS GANGETICUS* IN INDRAVATI RIVER?

Occurrence of the gharial (*Gavialis gangeticus*) in River Mahanadi, Orissa was often thought to be an exception. However, data presented in Singh and Bustard (1982a, 1982b) and Singh (1992) suggested occurrence of gharial in all major rivers of Orissa and in the Godavari in Andhra Pradesh. There was no information, then, from the River Indravati, Madhya Pradesh State.

When one of us (MKR) was in the Indravati area during 1981, a person informed of the occurrence of a long snouted crocodilian in the river some 16-20 years earlier, estimated to be around the late 1960s. The description obviously referred to the gharial, and differed from the description of the short snouted mugger (*Crocodylus palustris*). In 2000, when other people in the same area were interviewed by MKR, they had no idea of the occurrence of the gharial in Indravati river. The people questioned were young and probably had had no exposure to the previous generation's experiences. The presence of gharial in the River Indravati appeared to have vanished from the memory of the locals.

Nonetheless, the single piece of information about the gharial's occurrence in Indravati in the late 1960s bridges the gap in the distribution of the gharial, strengthening the view that *Gavialis gangeticus* had a continuous distribution from River Mahanadi to Godavari along eastern India.

Any further information on the gharial's occurrence in Orissa, Madhya Pradesh and Andhra Pradesh will be gratefully acknowledged.

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27. COMMUNAL EGG LAYING BY *CNEMASPIS INDICA* IN MUKURUTHI NATIONAL PARK, WESTERN GHATS, INDIA

(*With one text-figure*)

Indian geckoes are largely nocturnal, except species belonging to the genera *Cnemaspis* and *Phelsuma*. The biology of species referred to *Cnemaspis* is poorly known. In the present paper,

we report some aspects of the breeding biology, especially egg laying by *Cnemaspis indica* in Mukuruthi National Park (11° 10'-11°22' N, 76° 26'-76° 38' E), Nilgiri Biosphere Reserve, Western Ghats. *C. indica* is common in the high altitude montane grasslands, especially 2,000-2,500 m above msl. Currently, the true montane grasslands and shola are restricted to the Mukuruthi National Park, Tamil Nadu and adjacent areas in Kerala in the Nilgiris.

We sampled about 0.5 ha of grassland every month from October 2000 to April 2001, using randomly placed 25 sq. m quadrats. Fifteen nest sites with eggs were located during this period. The nests were found in crevices, under boulders that were usually placed on a rocky substratum. The number of eggs found in a site varied from 2 to 70 ($\bar{x}$ = 15.2, SD = ±21.6, n = 15). Mean length and width of 58 eggs found in a site was 5.5 mm and 4.4 mm, respectively.

The gecko nests were observed from October to April, and the greatest number of nests and eggs were found during December-February (Fig. 1). This shows that *C. indica* has an extended breeding season, October-April, with a peak during mid-winter. All nests found during January had many hatched eggs. This indicates that eggs did not hatch synchronously, and were laid on different days. More than one female would have used the same site for depositing eggs. In each nest, eggs were stuck to the rock in groups of three or two, or singly. A nest observed in February 2001 had 58 eggs, which were arranged in groups of three (7 clutches), two (13 clutches) and single eggs (11 clutches) totaling 31 clutches. Clutch size of the day geckoes in general is reported as 2-3 (Smith 1935).

Apart from several females laying eggs at the same site, it is possible that each one may

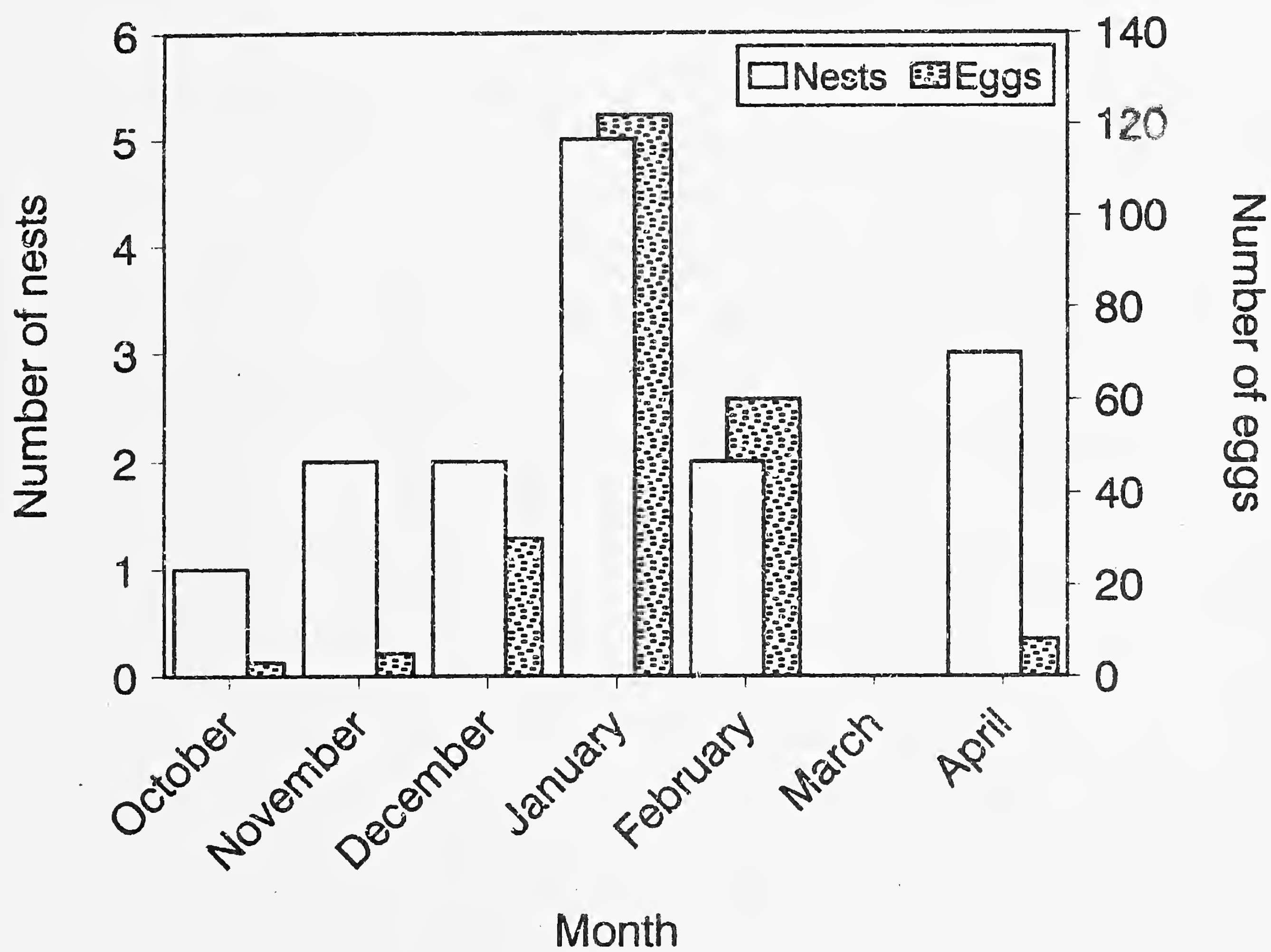

Fig. 1: Egg laying of *Cnemaspis indica* in Mukuruthi National Park, Western Ghats

have laid eggs more than once. However, the inter-nesting period is not known. The laying of eggs collectively by several females in the same site could be due to the scarcity of suitable sites. It appears that these sites have some specific microclimate such as temperature. Preliminary observations show that these sites have higher temperature than the general atmosphere. Warmer nest conditions may help faster embryonic development and hatching. Communal nesting (Smith 1935) in a suitable site is not uncommon in geckoes. Thirty eggs of *Hemidactylus frenatus* have been found in a wooden box embedded in the wall (Bhupathy, unpublished data). Many females of the endemic and endangered golden gecko, *Calodactylodes aureus* also deposit eggs collectively, and the number of eggs may exceed 40 at each site (Daniel, J.C. pers. comm.). Smith (1935) reported the largest number of 186 eggs in a nest of *Gekko japonicus*, perhaps an instance of communal egg laying.

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28. RANGE EXTENSION OF *RANA MALABARICA* (BIBR.) IN MADHYA PRADESH

One night in August 1999, while driving back to my camp (Wild Chalet, Mocha village), in the buffer zone of Kanha National Park in Madhya Pradesh, I stopped to watch a frog crossing the road. It looked like an interesting species, but I was unable to get down immediately as it was raining. Since I had seen similar frogs earlier in South West India, it did not take me long to identify it as the fungoid frog *Rana malabarica* (Bibr.). I never knew that this frog existed as far north as Mandla district in Madhya Pradesh, and after my first sighting, I kept a lookout for it to photograph and confirm my identification. I did not see that species during that season, but I instructed my local assistants to keep a lookout.

In May 2000, after a couple of pre-monsoon showers, a friend informed me that he had seen a number of colourful frogs in a newly dug well in the village of Mocha. I asked him to procure a specimen immediately, which he did. The live frog in a bottle confirmed the existence of *Rana malabarica* around Kanha. I kept the frog for about 24 hours and released it after photographing it. I went around the village trying to gather more information about this species, and saw some individuals in two or three wells (in May and June) sitting on the sides above the water. I never saw them actually living in water and I support the earlier observations on habits (Daniel 1975).

The occurrence of *Rana malabarica* observed in and around Kanha is an extension of its range. It was reported earlier from Jagdalpur in Bastar district (Daniel and Selukar 1964) now in Chattisgarh, about 350 km southeast of Kanha. The present report from Kanha in the Satpuras (Maikal Range) definitely strengthens the view that the species has a much wider distribution in the Peninsula. However, around Kanha, it is definitely not a common species, as it appears only during two or three months of the year, unlike in southwest India and also perhaps in Bastar, where it is stated to be not uncommon (Daniel and Selukar 1964). Essentially a forest dweller, *Rana malabarica* seems to prefer moist-deciduous biotopes to dry deciduous tracts and perhaps this explains why it is absent (?) between the Kasara Ghat (Maharashtra) and Eastern Satpura trend of hills with sal forests. Having been reported from Bastar already, the species may very well occur in the Eastern Ghats.

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29. A NOTE ON *MESONOEMACHEILUS HERREI* NALBANT AND BANARESCU (CYPRINIFORMES: BALITORIDAE: NOEMACHEILINAE)

(*With one plate*)

Mesonoemacheilus herrei described by Nalbant and Banarescu (in Asket Singh *et al.* 1981) was based on collections made from Puthutotam Estate, Valparai in Anamalai Hills by Herre in 1941, and identified as belonging to the species *guentheri*. Nalbant and Banarescu distinguished *herrei* from *guentheri* (described by Day from Nilgiri Hills), based on several characters, including differences in colour pattern and structure of scales (white spots on body being more roundish and regularly disposed in *guentheri* vs. white coloration 'V' or 'Y'-shaped in *herrei*; scales with reduced and eccentric focal zone in the former vs. a central and much larger focal zone in the latter).

Menon (1987), in his revisionary study of the Noemacheilids, treated *herrei* as a synonym of *guentheri*. However, Jayaram (1999), following Banarescu and Nalbant (1995), retained it as a separate species. No specimens of *herrei* were reported subsequent to its original description. Silas (1951), in his paper on the fishes of Anamalai and Nelliampathi Hill ranges, reported collection of *Noemacheilus triangularis* from the streams draining the Ponnani drainage system in the Nelliamathi Hills. *N. herrei*, especially the juveniles, superficially resemble both *guentheri* and *triangularis*, and the specimens named *triangularis* by Silas (op. cit.) could possibly be *herrei*, described subsequently by Nalbant and Banarescu. More recently, six survey teams of the Zoological Survey of India (1996-1998) collected three species of *Noemacheilus* from the Anamalais, namely *denisoni*, *herrei* and *monilis*.

A total of 27 specimens of *herrei*, ranging in length from 20.5-52 mm SL were collected from two localities and Kolikamuthi at altitudes 890 m and 870 m respectively. *M. herrei* (Plate 1, Fig.1) is reported here, and an attempt is made

to distinguish the species from *guentheri* (Plate 1, Fig. 2). A key to all the Mesonoemacheilid species, including two species described subsequent to the publication of Jayaram (1999) is also given.

Material studied: 3 exs., 30-34 mm SL, Reg. No. F.4941, Varagalayar, 890 m, 4.ii.1996, Coll. M.B. Raghunathan; 3 exs., 34-48 mm SL, F. 5772, Kolikamuthi, 870 m, 21.ii.1998, Coll. M.S. Ravichandran.

Morphometric characters measured by standard methods are presented in Table 1, mostly in relation to standard length and head length with the mean followed by the range in parentheses. The meristic characters are as follows. D. 3/7-8; P. 1/9-11; V. 1/7; A. 3/5; C. 1/16/1. Additional morphometric differences observed in larger specimens are detailed below. Fins and eye being larger in juveniles, it is difficult to segregate them based on these characters alone Table 1.

KEY TO THE *MESONOEMACHEILUS* SPECIES

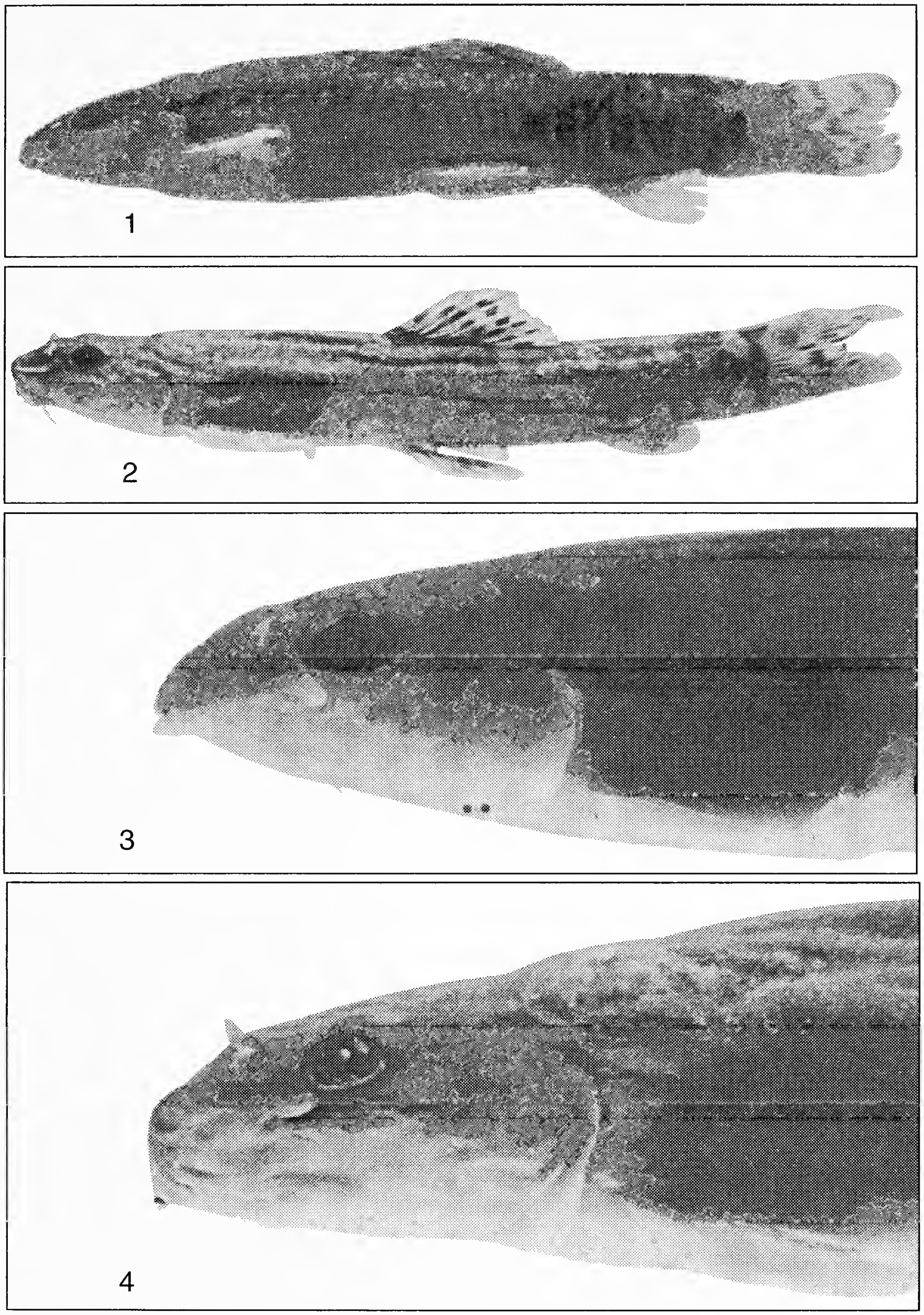
1. Dorsal with 10 branched rays .. *M. pulchellus*
— Dorsal with variable number of branched rays (8-10) 2
2. Dorsal with 7-8 branched rays; body depth less than 5.5 in SL 3
— Dorsal with 8-10, mostly 9, branched rays; body very elongate, depth more than 5.5 times in SL .... *M. pambarensis*
3. Two or three rows of large yellow spots edged with black on the sides 4
— Body with reticulate, oblique or vertical bands 5
4. Spots rounded; caudal peduncle long, anal not reaching caudal base; a band on caudal base .... *M. guentheri*
— . Spots V- or Y-shaped; caudal peduncle short; anal fin reaching caudal base; spot on caudal base present .... *M. herrei*
5. Body with reticulate pattern of dark wavy bands and blotches on lighter ground .... *M. menoni*
— Body with light oblique and vertical bands on darker or lighter ground 6
6. Body with 6-7 oblique light bands having black edges 7
— Body with irregular vertical dark bands 8
7. Distance from vent to anal fin about 4 times in the distance from pelvic to anal fin .... *M. triangularis triangularis*
— Distance from vent to anal fin about 6 times in the distance between pelvic and anal fin .... *M. triangularis tambraparanei*
8. Lateral line complete, 8 to 10 brown bands

TABLE 1

MORPHOLOGICAL COMPARISON OF *MESONOEMACHEILUS GUENTHERI* AND *M. HERREI*

	guentheri (Plate 1, Figs 2 & 4)		***herrei*** (Plate 1, Figs 1 & 3)
a.	Suborbital flap not pronounced, shorter than broad (Fig. 4).	:	Suborbital flap well-developed, longer than broad (Fig. 3).
b.	Nostrils situated more than half eye-diameter distance before eyes.	:	Nostrils closer to eyes, distance between nostril and eye less than half eye diameter.
c.	Lateral line prominent and complete.	:	Lateral line almost incomplete and distinct only up to anal origin, after which it is discontinuous or absent.
d.	Distance from pelvic to anal origin greater, pelvic fin reaching ½ the distance to anal origin.	:	Distance from pelvic to anal shorter, pelvic reaching ¾ the distance to anal origin.
e.	Caudal peduncle longer than broad.	:	Caudal peduncle as long as broad.
f.	Anal not reaching caudal base.	:	Anal reaching caudal base.
g.	Caudal base with a dark band	:	Caudal base with a well marked roundish blotch.

Rema Devi, K. & T.J. Indra: *Mesonoemacheilus* sp. PLATE 1



Figs 1-4: 1. Lateral view of *Mesonoemacheilus herrei*, 48 mm SL,
2. Lateral view of *Mesonoemacheilus guentheri*, 59 mm SL,
3. Enlarged view of head of *herrei* showing long suborbital flap,
4. Enlarged view of head of *guentheri* showing short suborbital flap

TABLE 1
MORPHOMETRIC DETAILS OF *HERREI* FROM INDIRA GANDHI WILDLIFE SANCTUARY

Characters	% SL
Head length	23.81 (22.52-25.37)
Body depth	17.34 (16.87-18.59)
Predorsal distance	50.25 (47.84-52.91)
Postdorsal distance	49.26 (44.64-52.08)
Prepelvic distance	51.81 (50.76-53.47)
Preanal distance	77.52 (72.46-80.00)
Length of Caudal fin	25.97 (25.0-29.41)
Length of Pectoral fin	20.79 (18.35-22.02)
Length of Pelvic fin	17.73 (16.61-18.65)
Length of Anal fin	13.89 (13.55-14.39)
Length of Body cavity	51.02 (49.50-52.35)
Length of caudal peduncle	13.23 (12.16-14.77)
	%HL
Eye diameter	19.01 (16.66-20.28)
Snout length	35.71 (33.33-36.63)
Inter-orbital width	28.65 (26.31-31.15)
Length of Pectoral fin	87.72 (81.30-91.74)
Snout-Eye diameter	53.19 (46.95-59.17)
Inter-Orbital width/Eye diameter	66.22 (58.48-74.07)
Body depth/Body width	87.72 (85.47-92.59)
Caudal fin/Head length	19.27 (16.26-21.69)
Distance between Pelvic to anal fin /Distance between anus to anal fin	19.27 (16.26-21.69)
Length of caudal peduncle/ Height of caudal peduncle	101.01 (90.09-111.11)
Distance between Pectoral to Ventral fin /Distance between Ventral to Anal fin	90.09 (83.33-101.01)

across back, broken up into secondary bands below lateral line; males with suborbital spine .... *M. sijuensis*

— Lateral line incomplete; males without suborbital spine 9

9. Lateral line ending below dorsal fin or slightly in front of it, with a number of irregular V- or Y-shaped cross bands ..... *M. reticulofasciatus*

— Lateral line ending above end of anal fin base (7 or 8 saddle-shaped black bands on back; sides marked by varying number of bands broken up into narrow bands anteriorly .... *M. petrubanarescui*

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30. FISH FAUNA OF SOME STREAMS AND RIVERS IN THE WESTERN GHATS OF MAHARASHTRA

The documentation of fish fauna is essential, as major changes have occurred in the streams and rivers of the Western Ghats, in the Indian peninsula. Major rivers, such as the Godavari, Krishna and the Bheema, originate in the Maharashtra part of the Western Ghats. This documentation is part of a detailed programme on fish diversity in Western Ghats

TABLE 1
FISH SPECIES AND THEIR CONSERVATION STATUS AT DIFFERENT SITES IN SOME STREAMS AND RIVERS IN MAHARASHTRA

	Species**	Sites* 1	2	3	4	5	6	7	8	9	10
I.	**Order**: Elopiformes										
i	**Family**: Megalopidae										
a.	**Genus**: Megalops										
	1. *Megalops cyprinoides* (NA)	-	x	-	-	-	-	-	-	-	-
II	**Order**: Cypriniformes										
ii.	**Family**: Cyprinidae										
b.	**Genus**: *Labeo*										
	2. *Labeo boggut* (NA)	-	x	-	-	-	-	-	-	-	-
	3. *Labeo calbasu* (LRnt)	-	-	-	x	-	-	-	-	-	-
c.	**Genus**: *Osteobrama*										
	4. *Osteobrama cotio peninsularis* (NA)	x	-	-	-	-	-	-	-	-	-
d.	**Genus**: *Puntius*										
	5. *Puntius amphibius* (NA)	x	-	-	-	-	-	x	-	-	-
	6. *Puntius bimaculatus* (NA)	-	-	-	-	-	x	-	-	-	-
	7. *Puntius conchonius* (VU)	-	-	-	-	x	-	-	-	-	-
	8. *Puntius sahyadriensis* (NA)	x	-	-	-	-	-	-	-	x	-
	9. *Puntius sarana* (VU)	x	x	x	-	-	-	x	-	-	-
	10. *Puntius sarana subnasutus* (NA)	x	-	-	-	-	-	-	-	-	-
	11. *Puntius sophore* (LRnt)	-	-	-	-	-	-	-	x	-	-
	12. *Puntius ticto* (LRnt)	x	-	-	-	x	-	x	-	-	-
e.	**Genus**: *Hypselobarbus*										
	13. *Hypselobarbus dubius* (EN)	-	x	-	-	-	-	-	-	-	-
f.	**Genus**: *Tor*										
	14. *Tor khudree* (VU)	-	-	-	-	x	-	-	-	-	x
g.	**Genus**: *Chela*										
	15. *Chela laubuca* (LRlc)	-	x	-	-	-	-	-	x	-	-
h.	**Genus**: *Salmostoma*										
	16. *Salmostoma boopis* (NA)	x	-	-	-	x	-	-	-	-	-
	17. *Salmostoma clupeoides* (LRlc)	-	x	-	-	-	-	-	-	-	-
	18. *Salmostoma novacula* (LRnt)	x	-	-	-	-	-	-	-	-	-
	19. *Salmostoma sardinella* (NA)	x	-	-	-	-	-	-	-	-	-
i.	**Genus**: *Barilius*										
	20. *Barilius bendelisis* (LRnt)	x	-	-	-	-	-	-	-	-	-
j.	**Genus**: *Danio*										
	21. *Danio aequipinnatus* (LRnt)	x	-	x	x	x	x	-	x	x	-
k.	**Genus**: *Parluciosoma*										
	22. *Parluciosoma daniconius* (LRnt)	x	-	x	-	x	x	x	x	x	x
l.	**Genus**: *Garra*										
	23. *Garra mullya*	x	-	-	x	x	x	x	x	x	-
iii.	**Family**: Parapsilorhynchidae										
m.	**Genus**: *Parapsilorhynchus*										
	24. *Parapsilorhyncus tentaculatus* (NA)	-	-	-	-	-	x	-	-	-	-
iv.	**Family**: Cobitidae										
n.	**Genus**: *Nemacheilus*										
	25. *Nemacheilus denisoni denisoni* (NA)	x	x	-	x	-	-	x	-	x	-
	26. *Nemacheilus evezardi* (NA)	-	-	-	-	x	-	-	-	-	-
	27. *Nemacheilus ruppelli* (NA)	x	-	-	x	x	x	-	-	-	x
o.	**Genus**: *Lepidocephalus*										
	28. *Lepidocephalus thermalis* (NA)	-	-	-	-	x	-	-	-	-	

TABLE 1 (CONTD.)
FISH SPECIES AND THEIR CONSERVATION STATUS AT DIFFERENT SITES IN SOME STREAMS AND RIVERS IN MAHARASHTRA

	Sites*									
Species**	1	2	3	4	5	6	7	8	9	10
III **Order**: Siluriformes										
v. **Family**: Bagridae										
p. **Genus**: *Mystus*										
29. *Mystus bleekeri* (VU)	x	-	-	-	-	-	-	-	-	-
30. *Mystus malabaricus* (EN)	-	-	-	x	-	x	-	-	-	-
31. *Mystus vittatus* (VU)	-	-	-	x	-	-	-	-	-	-
vi. **Family**: Siluridae										
q. **Genus**: *Silurus*										
32. *Silurus wynaadensis* (CR)	x	-	-	-	-	-	-	-	-	-
r. **Genus**: *Wallago*										
33. *Wallago attu* (LRnt)	-	x	-	-	-	-	-	-	-	-
IV **Order**: Cyprinodontiformes										
vii. **Family**: Cichlidae										
s. **Genus**: *Aplocheilus*										
34. *Aplocheilus lineatus* (NA)	-	-	-	-	-	-	-	x	-	-
V **Order**: Perciformes										
viii. **Family:** Ambassidae										
t. **Genus**: *Chanda*										
35. *Chanda nama* (NA)										
ix. **Family**: Gobiidae										
u. **Genus**: *Glossogobius*										
36. *Glossogobius giuris* (LRnt)	-	-	-	x	x	x	-	-	-	-
v. **Genus**: *Stigmatogobius*										
37. *Stigmatogobius oligactis* (NA)	-	-	-	-	x	-	-	-	-	-
VI **Order**: Channiformes										
x. **Family**: Channidae										
w. **Genus**: *Channa*										
38. *Channa marulius* (LRnt)	x	x	-	-	-	-	-	-	-	-
VII **Order**: Mastacembeliformes										
xi. **Family**: Mastacembelidae										
x. **Genus**: *Mastacembelus*										
39. *Mastacembelus armatus* (NA)	-	-	-	x	x	-	-	-	-	-

x present; - absent
*1. Mondai 2. Khal river 3. Pej river 4. Vasishti river 5. Dhom reservoir 6. Phansad 7. Savitri 8.Gundalika 9. Vethaganga 10. Khandala Falls.
** LRnt – Lower Risk near threatened; LRlc – Lower Risk least concern; En – Endangered; VU – Vulnerable; CR – Critically Endangered; NA – Not Assessed (Sanjay Molur and Sally Walker, 1998)

the streams/rivers in Maharashtra, under the Western Ghats Biodiversity Project.

Earlier workers on the fish fauna of Maharashtra State include Fraser (1942), Hora and Misra (1942) and Suter (1944). In the Maharashtra State Gazette, there is a brief account of fishes in and around Pune (Kulkarni and Ranade 1974) including 167 species with their local (Marathi) and English names. Tilak and Tiwari (1976) studied the fishes from the Indrayani River. The fish fauna of Ujni wetland of Pune was studied by Yazdani and Singh (1990). Ghate *et al.* (1992) contributed on the fishes from Mula and Mutha rivers. Ghate and Pawar (1992) also documented the fish fauna from Neerar River, Pune.

1. Mondai stream: The Mondai stream starts from Mandhardevi hill ranges and joins Neerar river. Fishes were collected a kilometre from Shirrai in Satara district.
2. Khal river: Originates from Bhirra, in Raigad district, Maharashtra.
3. Pej river: Pej river flows in Khed on the northern side of Pune district. Sampling was done at Khed.
4. Vasishti river: Originates near Koynanagar on the western side of Chiplun area, and flows west in Ratnagiri district. Sampling was carried out near Chiplun.
5. Dhom river: Dhom reservoir is a man-made impoundment on the Dhom river.
6. Phansad river: Streams flow in the Phansad Wildlife Sanctuary in Murud taluka, Raigad district.
7. Savitri river: Originates from Mahabaleshwar and flows westwards. Sampling was done 15 km from Mahabaleshwar in Raigad district.
8. Gundalika river: Flows westward and into the sea at Roha. Sampling was done at Kolad.
9. Vethaganga river: A tributary of River Krishna, flows through Kolhapur district, Maharashtra.
10. Khandala Falls: Situated in Khopoli, it is a small drainage. Sampling was done near Kunega.

Fishes were collected using various mesh sizes of monofilament gill nets, drag nets and scoop nets in November and December 1996. The colour, markings and interesting characters were noted and specimens were preserved in 10% formalin. Day (1878), Jayaram (1991, 1999); Menon (1992, 1999); Talwar and Jhingran (1991) were referred to for identification.

Thirty-nine species belonging to 7 orders, 11 families and 24 genera from 10 localities were collected (Table 1). Most of these are widely distributed in Maharashtra and also in other parts of the Western Ghats. *Danio aequipinnatus*, *Garra mullya*, *Rasbora daniconius*, *Glossogobius giuris*, *Nemacheilus denisoni* are the commonest forms in Maharashtra State. *Puntius sahyadriensis*, *Chela laubuca*, *Osteobrama cotio peninsularis*, *Wallago attu*, *Silurus wynaadensis* and *Salmostoma novacula* were rare forms.

Salmostoma sardinella; *Silurus wynaadensis*, *Puntius bimaculatus*, *Puntius conchonius*, *Hypselobarbus dubius* were new records for Maharashtra and *Stigmatogobius oligactis* from Dhom reservoir was a new record for India (Arunachalam *et al.* 1999a, b; Arunachalam *et al.* 2000). The species was previously recorded from rivers of Java (Weber and Beaufort 1953).

Juveniles of *Tor khudree* were recorded in Dhom reservoir and large numbers were also recorded from Khandala falls. An interesting character in the juveniles of *Tor khudree* is the small black spot on the caudal peduncle region.

Industrialization and urbanization are the major threats to the fish communities and habitats in Maharashtra.

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31. CHECKLIST OF ANTS FROM NORTHWEST INDIA-II

In India, no comprehensive work is available on the Family Formicidae (Insecta: Hymenoptera) since Bingham (1903), which mostly covers taxa from southern India, Burma (=Myanmaar) and Sri Lanka. Since then, several taxonomic changes have been made. The present studies were carried out under a DST project on ants from northwest India and 8 subfamilies with 43 genera and 100 species have been recorded. Out of these, 13 new species have been reported. Two subfamilies, namely Dolichoderinae and Formicinae have been discussed.

SUBFAMILY: DOLICHODERINAE

1. ***Bothriomyrmex dalyi*** Forel 1895
   Collected from plains (250 to 300 m).
   Additional locality: Bengal.
2. ***Bothriomyrmex wroughtonii*** Forel 1895
   Plains, in soil nests (250 to 330 m).
3. ***Iridomyrmex glaber*** (Mayr 1862)
   Earlier reported from Western India, now collected from Chintpurni (700 m), Himachal Pradesh; Rohtak (220 m), Haryana.
4. ***Tapinoma indicum*** Forel 1895
   Nest in soil, mainly in plains; reported only

from northwest India.

5. ***Tapinoma melanocephalum*** (Fabricius 1793)

Nest in soil, also in leaf litter; plains and foothills; widely distributed all over India.

SUBFAMILY: FORMICINAE

1. ***Acropyga acutiventris*** Roger 1862

Collected from Jahalman village near Keylong (3,100 m), Himachal Pradesh; restricted to northwestern region.

2. ***Camponotus angusticollis*** (Jerdon 1857)

Widespread in northwest India.

Additional localities: Central India, Assam.

3. ***Camponotus arrogans*** (Smith 1858)

Collected from Malakpur near Pathankot (400 m), and Mukerian (300 m), Punjab.

Additional locality: Bengal.

4. ***Camponotus buddhae*** Forel 1892

Collected from Lahoul (3,000 m), Himachal Pradesh; reported earlier from the same locality.

5. ***Camponotus compressus*** (Fabricius 1787)

Widely distributed.

6. ***Camponotus dichrous*** Forel 1886

Restricted to northwest Himalayas; collected from same belt.

7. ***Camponotus dolendus*** (Forel 1892)

Collected from Lahoul (3,000 m), Himachal Pradesh; reported earlier from northwest Himalayas.

8. ***Camponotus invidus*** Forel 1892

Collected from Dehra Dun (660 m), Uttaranchal; Lahoul (3,000 m), Himachal Pradesh.

Additional locality: Orissa.

9. ***Camponotus lamarckii*** Forel 1892

Collected from Terrace (400m), Himachal Pradesh.

Additional locality: Sikkim.

10. ***Camponotus oblongus*** (Smith 1858)

Collected from Gobinddham (3,000 m), Uttaranchal; Dunera (700 m), Himachal Pradesh; reported to be widely distributed.

11. ***Camponotus misturus*** (Smith 1857)

Found to be widely distributed in northwestern India and represents first report from India.

12. ***Camponotus sericeus*** (Fabricius 1798)

Widely distributed in India.

13. ***Camponotus taylori*** Forel 1894

Widely distributed in India.

14. ***Camponotus wasmani*** Emery 1893

Collected from Dunera (700 m), Himachal Pradesh; Chohal (400 m), Punjab.

Additional locality: Sikkim, Assam.

All the species of *Camponotus* were found in diverse habitats, most of them among the roots of various trees like *Dalbergia*, *Mangifera*, *Acacia*, *Cassia*, and *Zizyphus* and collected in plains, foothills and high altitude regions. Workers generally have large mandibles and are mostly polymorphic.

15. ***Cataglyphis setipes*** (Forel 1894)

Collected from soil nests in extremely hostile environments with high temperature, nests in direct sunlight, in areas ranging from plains to small hills.

Additional locality: Central India.

16. ***Formica gagates*** Latreille 1798

17. ***Formica sanguinea*** Latreille 1798

Both species collected from Lahoul (3,000 m), Himachal Pradesh and earlier reported from the same region.

18. ***Lasius alienus*** (Foerster 1850)

19. ***Lasius himalayanus*** Bingham 1903

Both species collected mainly from trees at Kulu (1,219 m), Manali (2,050 m), and Lahoul (3,000 m), Himachal Pradesh; no additional locality apart from northwest India.

20. ***Lepisiota frauenfeldi*** Mayr 1855

21. ***Lepisiota opaca*** (Forel 1892)

Both species of *Lepisiota* widely distributed in India.

22. ***Oecophylla smaragdina*** Fabricius 1775

Widely distributed in India.

23. ***Paratrechina birmana*** (Forel 1902)

Collected from soil nest in plains, widely distributed in India.

24. ***Paratrechina longicornis*** (Latreille 1802)

Collected from soil nest, also from dead wood and even carcasses, from plains to foothills, and is widely distributed.

25. ***Plagiolepis* sp.** Mayr 1861

Only collected from Keylong (3,300 m), Himachal Pradesh; earlier reported from northwestern, southern and eastern India.

26. ***Polyrhachis jerdoni*** Forel 1892

Collected from Dunera (700 m), Himachal Pradesh; Pathankot (620 m), Punjab.

Additional locality: Assam; represents first record from India.

27. ***Polyrhachis rupicapra*** Roger 1862

Collected from Malakpur near Pathankot (400 m), Punjab and also represents first record from India.

28. ***Prenolepis naorojii*** Forel 1902

Collected from Dunera (700 m), Himachal Pradesh.

Additional locality: Assam.

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32. ON THE DIPTERA OF NAYACHAR ISLAND, WEST BENGAL

(*With one text-figure*)

The study of island fauna, whether oceanic or riverine, is always interesting. Nothing was known of the Diptera fauna of the Nayachar Island until the project "Faunal succession in relation to vegetation of the newly emerged Nayachar Island" on the River Hooghly, near Haldia was started in 1992. The present investigation is part of a long-term study on the succession and the diversity of Dipteran fauna on a newly emerged island. The main objective here is to give a comprehensive account of the Diptera of the island.

Brief description of sites: Nayachar Island is situated on the River Hooghly, near the mouth of River Haldi, Midnapore district, West Bengal (Fig. 1). Nayachar is a spindle-shaped, silt deposited island with an area of about 29.36 sq. km, formed due to continuous riverine action at the mouths of the Hooghly and Haldi. The distance between this island and the nearest landmass Haldia of Midnapore is only 3 km. The topography of the island is flat and the average height from water level is about 0.90-3 m (Hazra *et al.* 1996). The vegetation comprises mainly natural grasslands and mangrove plants.

SYSTEMATIC ACCOUNT

Suborder: Brachycera
Family: Stratiomyidae
Subfamily: Stratiomyinae

1. ***Microchrysa flaviventris*** (Wiedemann)

1824. *Sargus flaviventris* Wiedemann, *Analecta Ent*: 31.

Material examined: 1 ♂, Nayachar, 28.x.1998, coll. B. Mitra.

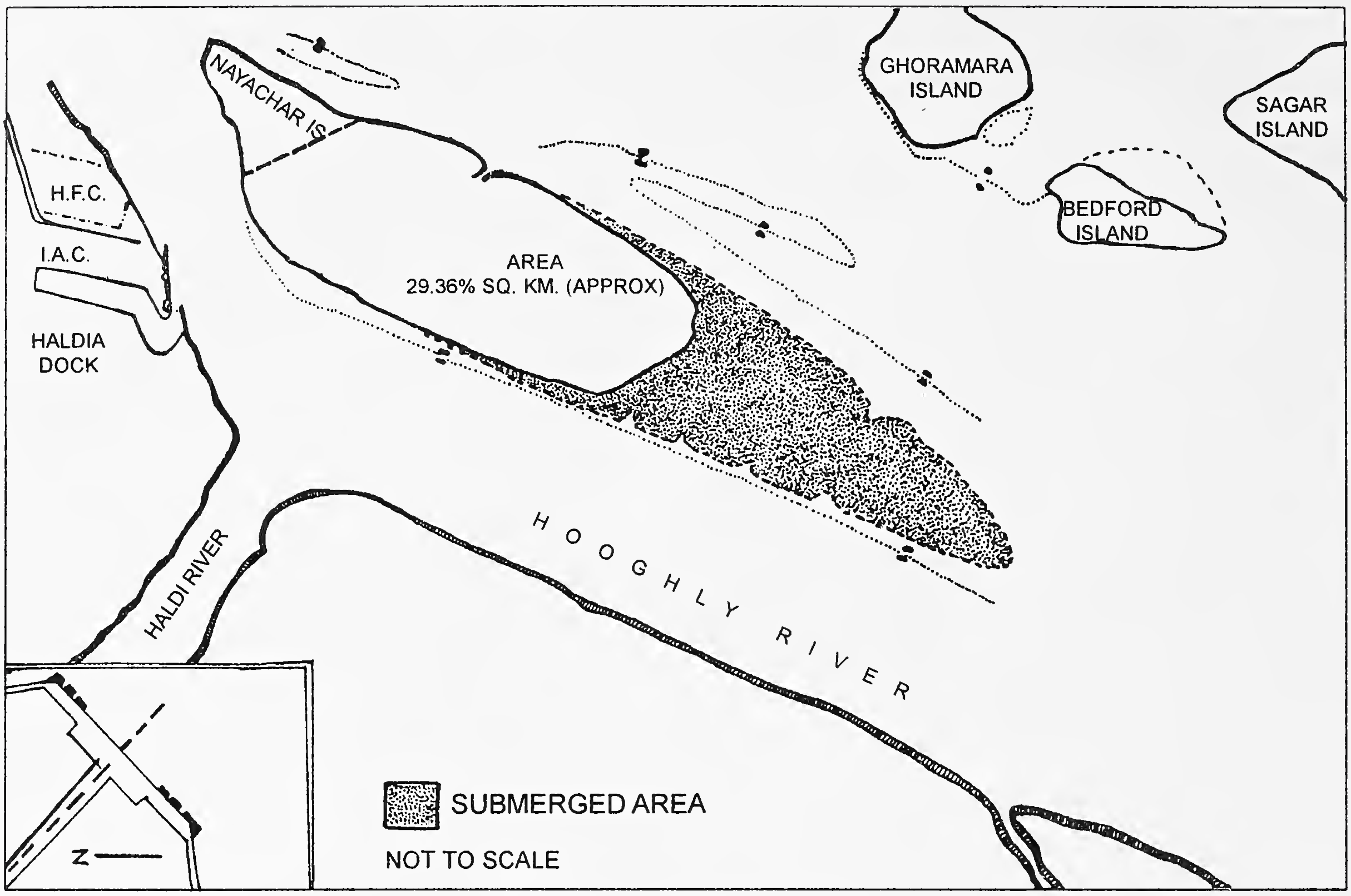

Fig. 1: Map of Nayachar Island

Diagnosis: Vertex black, shining, ocelli red, in male upper facets of eye brown, much longer than lower black ones; antenna pale yellow; thorax shining metallic green with scattered pale-yellow pubescence; scutellum concolourous with thorax; legs pale brown, hind femur with broad median brown band, hind tibia with paler apical band; abdomen brownish-yellow with pale yellow microscopic pubescence.

Distribution: West Bengal, widespread.

Family: Tabanidae

Subfamily: Tabaninae

2. ***Tabanus* (*Tabanus*) *striatus*** Fabricius

1787. *Tabanus striatus* Fabricius, *Mantissa Insecta,* 2: 356.

Material examined: 2 ♀, Rest house site, 28.ix.1996, coll. A.K. Hazra; 2 ♀, Kulpi side khal, 29.x.1998, coll. A.K. Hazra & A.K. Sanyal; 1 ♀, Hut side, 25.ii.1999, coll. A.K. Hazra & A.K. Sanyal.

Diagnosis: Antennae rusty yellow; callus square; thorax with 4 broad whitish stripes and with a line in the middle; wing hyaline; femora rusty brown, tibiae paler, tarsi blackish; abdomen with 5 stripes.

Distribution: West Bengal, India.

Family: Asilidae

Subfamily: Asilinae

3. ***Philodicus femoralis*** Ricardo

1921. *Philodicus femoralis* Ricardo, *Ann. Mag. nat. Hist. (9)8*: 190.

Material examined: 1 ♀, Rest house site, 26.xi.1999, coll. A.K. Hazra and A.K. Sanyal.

Diagnosis: Mystax pale yellow with a few black bristles on lower side; thorax dark brown with mediolongitudinal dark brown stripe extending the entire length; legs dark brown, femora comparatively light coloured, mid and hind femora bear more than one row of bristles; wing medially hyaline and rest brownish;

abdomen dark brown with hind border of tergites grey.

Distribution: West Bengal (South), Arunachal Pradesh, Bihar, Goa, Kerala, Meghalaya and Orissa.

Suborder: Cyclorrhapha

Family: Lonchopteridae

4. ***Lonchoptera guptai*** Joseph and Parui

1981. *Lonchoptera guptai* Joseph and Parui, *Bull. Zool. Surv. India, 4(3)*: 255-256.

Material examined: 1 ♂, Rest house site, 19.viii.1992, coll. A.K. Hazra and party.

Diagnosis: Head and thorax black to dark brown, the latter with anterior border and posterolateral sides lighter; legs pale yellow, hind femur apically brown; wing light yellow; haltere light yellowish; abdomen dark brown to black, ventrally lighter.

Distribution: West Bengal and Uttar Pradesh.

Family: Syrphidae

Subfamily: Syrphinae

5. ***Ischiodon scutellaris*** (Fabricius)

1805. *Scaeva scutellaris* Fabricius, *Syst. Antliat*: 252.

Material examined: 1 ♂, Rest house site, 28.xi.1999, coll. A.K. Hazra and A.K. Sanyal.

Diagnosis: Eyes bare; metasternum bare; antennal segment 3, subacute apically; wing with vein R_{4+5}; upcurved apically and ending appreciably before wing apex; upper margin of sternopleuron with distinct yellow spot; a few short hairs anteriorly below upper patch of sternopleural hairs; surstylus elongate, directed posteriorly, broadened beyond base, not lobed.

Distribution: West Bengal (South), common in India.

Subfamily: Milesinae

6. ***Eristalinus (Eristalinus) arvorum*** (Fabricius)

1787. *Syrphus arvorum* Fabricius, *Mantissa Insecta*, 2: 335

Material examined: 1 ♀, Nayachar, 16.xii.1992, coll. A.K. Hazra.

Diagnosis: Antenna bright orange, tip of third antennal segment darker; scutum with 4 black stripes; scutellar disc bears dense yellow pubescence except at centre which has black pubescence; legs brownish-yellow or orange except a portion of all tibiae which is blackish; abdomen black, first tergite pale yellow; second with two oblong yellow spots, third with a pair of oval spots, fourth with a curved yellow spot.

Distribution: Southern West Bengal, Arunachal Pradesh, Delhi, Jammu and Kashmir, Meghalaya, Orissa, Sikkim and Tripura.

Family: Sepsidae

Subfamily: Sepsinae

7. ***Australosepsis frontalis*** (Walker)

1860. *Sepsis frontalis* Walker, *J. Proc. Linn. Soc. Lond, Zool.*, 4: 163.

Material examined: 4 ♂, Kulpi side khal, 29.x.1998, coll. A.K. Hazra and A.K. Sanyal.

Diagnosis: Wing without a diffused dark spot at end of vein R_{2+3}.

Distribution: West Bengal, Andhra Pradesh, Bihar, Kerala, Maharashtra and Punjab.

8. ***Dicranosepis bicolor*** (Wiedemann)

1830. *Sepsis bicolor* Wiedemann, *Aussereurop. zweifl. Insekt.*, 2: 468.

Material examined: 2 ♂, Rest house site; MIC, 11.xii.1997, coll. A.K. Hazra and A.K. Sanyal; 5 ♂, 2 ♀, Rest house site, 12.xii.1997, coll. A.K. Hazra and party.

Diagnosis: Wing unspotted; in male fore femur without posteroventral setae sub-basally, hind metatarsus without a row of long anterior setae, middle metatarsus with no strong bristles.

Distribution: West Bengal; widespread in India.

9. ***Sepsis indica*** Wiedemann

1824. *Sepsis indica* Wiedemann, *Analecta Ent*: 57.

Material examined: 1 ♂, 1 ♀, Rest house site, 11.xii.1997, coll. A.K. Hazra and A.K Sanyal.

Diagnosis: Head reddish-yellow to black; thorax reddish-yellow with a broad blackish dorsal stripe which sometimes occupies the whole of thorax, sides of thorax with a broad greyish white shimmering band across the stenopleur, dorsocentral 4; scutellum and metanotum reddish-yellow; legs reddish-yellow, hind tibiae dark brown; all tarsi black towards tip; wing clear; abdomen reddish-yellow with irregular black mark.

Distribution: West Bengal, Assam, Kerala, Maharashtra, Mizoram, and Manipur.

Family: Ephydridae

Subfamily: Parydrinae

10. ***Ochthera brevitibialis*** de Meijere

1908. *Ochthera brevitibialis* de Meijere, *Tijdschr. Ent.*, 51:167.

Material examined: 3 ♂, Hut side, 12.xii.1997, coll. A.K. Hazra and A. K. Sanyal.

Diagnosis: Face golden yellow pruinose, frons shining green; thorax bluish-black with a pair of brown longitudinal stripes, chaetotaxy not distinguishable, scutellum unicolorous with thorax, with 4 bristles; fore femur black, length twice its greatest thickness.

Distribution: West Bengal, Assam and Tamil Nadu.

Family: Muscidae

Subfamily: Muscinae

11. ***Musca (Musca) domestica*** Linnaeus

1758. *Musca domestica* Linnaeus, *Syst. Nat.* Ed. 10, 1: 596.

Material examined: 1 ♂, Hut side, 12.xii.1997, coll. A.K. Hazra and A.K. Sanyal.

Diagnosis: Four black vittae on thorax, inner pair terminating at posterior end; propleural depression with fine setulose hairs; suprasquamal ridge without black setulae, all post dc strong; mid tibia without av and ad setae.

Distribution: West Bengal, cosmopolitan.

12. ***Orthellia indica*** (Robineau-Desvoidy)

1830. *Lucilia indica* Robineau-Desvoidy, *Mem. Pres. Div. Sav. Acad. Sci. Inst.*, Fr. 2: 453.

Material examined: 6 ♂, 5 ♀, Hut side, 19.viii.1992, coll. A.K. Hazra and party; 7 ♀, Hut side, 12.xii.1997, coll. A.K. Hazra and A.K. Sanyal.

Diagnosis: Bronze-green to bluish-green in colour; presutural acrostichal absent, postalar 3, anterior mesopleural present, sternoplural 1+3; discal cell with a stripe at base, vein M_{1+2} with a distinct deep bend behind; legs without metallic reflections, mid tibia with an ad seta beyond apical fourth.

Distribution: West Bengal, Andaman Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Madhya Pradesh, Maharashtra, Sikkim, Tamil Nadu, Tripura, and Uttar Pradesh.

Family: Calliphoridae

Subfamily: Chrysomyinae

13. ***Chrysomya megacephala*** (Fabricius)

1794. *Musca megacephala* Fabricius, *Syst. Ent.* 4: 317.

Material examined: 5 ♂, 2 ♀, Rest house site, 19.viii.1992, coll. A.K. Hazra and party.

Diagnosis: Eyes in male with markedly enlarged facets on upper two-thirds, lower one-third with small facets; parafacialia and genae yellowish-orange, both covered with yellowish-white hairs; antennal segment 3 entirely orange; thorax and abdomen greenish-blue with purple lustre; wing hyaline, dark at base, subcostal sclerite covered with brown pubescence and a few short erect hairs, upper squama white, dark margined.

Distribution: West Bengal, also common in other parts of India.

Subfamily: Rhyniinae

14. ***Stomorhina discolor*** (Fabricius)

1794. *Musca discolor* Fabricius, *Ent. Syst.*, 4: 320

Material examined: 1 ♀, Rest house site, 26.ii.1999, coll. A.K. Hazra and A.K. Sanyal.

Diagnosis: Antenna and palpus brown; cell R5 narrowly open; abdomen yellowish with black bands posteriorly on terga 1 and 2, and with a median longitudinal black stripe.

Distribution: Southern West Bengal, Assam, Arunachal Pradesh, Bihar, Kerala, Manipur and Uttar Pradesh.

Family: Tachinidae

Subfamily: Tachininae

15. ***Thelaira macropus*** (Wiedemann)

1830. *Dexia macropus* Wiedemann, *Aussereur. Zweiflugel. Ins.*, 2: 375.

Material examined: 1 ♂, Rest house site, 28.vii.1998, coll. B. Mitra.

Diagnosis: Medium size (body 11.5-15.0 mm, wing 9.0-16.5 mm). Black subdorsum and sides of abdomen from near base to middle T_4 yellow. Face wider than frons; epistome not raised; vibrissae bifurcated at epistomal margin; facial ridge with a few hairs close to vibrissae; arista plumose; orbitals not differentiated; scutellum with a pair of discal and three pairs of marginal setae, of which the apicals are raised, cruciate and slightly shorter than subapicals; 3+3 *Ac*, 3+3 *dc* and 1+3 *ia* setae; R_1 more than half way to apex and R_{4+5} upto r-m setulose. Abdomen with T_{1+2} excavate nearly to its hind margin; segments T_{1+2} and T_3 each with a pair of median marginal setae, segments T_3 and T_4 each with a pair of median discal setae.

Distribution: West Bengal, Assam, Himachal Pradesh and Kashmir.

ACKNOWLEDGEMENTS

We thank Dr. J.R.B. Alfred, Director, Zoological Survey of India for placing the material at our disposal for study. We are grateful to Dr. S.K. Mitra, Joint Director, for facilities and to Dr. M. Datta, Scientist 'SE' and Officer-in-charge, Diptera section for valuable advice; to Dr. A.K. Hazra and Dr. A.K. Sanyal Scientist 'SE' for the opportunity to work with them under the project in Nayachar Island.

January 8, 2001

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33. NEW LARVAL FOOD PLANT OF THE BLUE TIGER BUTTERFLY *TIRUMALA LIMNIACE* (CRAMER), LEPIDOPTERA: DANAIDAE

While studying butterflies near the Botanical Garden of the Government College campus, Madappally, Vatakara, Kerala from October to November 1999, I came across a plant on which I observed a large number of small eggs and larvae of a butterfly. Rearing the larvae to maturity, I identified the butterfly as *Tirumala limniace* (Cramer). The plant was later identified as *Cosmostigma racemosa* (Asclepiadaceae). According to Wynter-Blyth (1957), the food plants of *T. limniace* are *Dregea volubilis, Calotropis gigantea, Marsdenia tenacissima, Hoya carnosa, Tylophora indica* and *Asclepias curassavica* (all Asclepiadaceae). Thus, *Cosmostigma racemosa* is a new larval food plant for *Tirumala limniace.*

ACKNOWLEDGEMENTS

I thank Dr. A.K. Pradeep, Dept. of Botany, University of Calicut for identifying the host plant.

July 26, 2000

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REFERENCE

WYNTER-BLYTH, M.A. (1957): Butterflies of the Indian Region. Bombay Natural History Society, Bombay.

34. NEW LARVAL FOOD PLANT OF THE GRASS DEMON *UDASPES FOLUS* CRAMER AND THE RESTRICTED DEMON *NOTOCRYPTA CURVIFASCIA* FELDER & FELDER, LEPIDOPTERA: HESPERIIDAE

While studying the butterfly fauna near the Botanical Garden of the Government College Campus, Madappally, Vatakara, Kerala, in October-November 1999 and August-October 2000, I recorded a new larval food plant for the larvae of the Grass Demon *Udaspes folus* Cram. and Restricted Demon *Notocrypta curvifascia* Felder & Felder, Lepidoptera.

Udaspes folus and *Notocrypta curvifascia* larvae were found to feed on the leaves of *Alpinia calcarata* Rosc. (Zingiberaceae). The recorded food plants of Grass Demon are *Curcuma domestica*, *C. aromatica*, *C. amada*, *C. caesia*, *C. zedoaria*, *C. decipiens*, *C. angustifolia*, *Zingiber officinale*, *Hedychium coronarium*, *Elettaria cardamomum*, *Aframomum melegueta* (all Zingiberaceae), *Maranta arundinacea* (Marantaceae) and *Tigridia pavonia* (Iridaceae) Seitz (in Sevastopulo, 1973) noted *Fagraea racemosa* (Loganiaceae) and Kershaw (in Abraham *et al*, 1975) noted *Alpinia nutans* Rosc., (in Hong Kong) as the food plant of the Grass Demon. According to Mackinnon (in Wynter-Blyth 1957), it also feeds on grasses.

Restricted Demon larva has been recorded to feed on *Kaempferia rotunda*, *Zingiber purpureum* (=*Z. cassumunar*) and *Curcuma decipiens* (all Zingiberaceae). Wynter-Blyth (1957) does not mention *Alpinia calcarata* Rosc., occurrence and successful rearing of Grass Demon *Udaspes folus* Cram., and Restricted Demon *Notocrypta curvifascia* Felder & Felder on *Alpinia calcarata* confirms it as a new larval food plant for both the species.

ACKNOWLEDGEMENTS

I thank Dr. A.K. Pradeep, Department of Botany, University of Calicut for identifying the host plant, and Chandrika Mohan. Scientist, CPCRI (RS), Kayamkulam for literature.

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35. BIODIVERSITY OF MANTIDS, INSECTA: MANTODEA, IN PUNE (WESTERN GHATS) WITH NOTES ON OTHER REGIONS OF MAHARASHTRA

Accelerating rates of biodiversity loss and signing of international agreements, such as the Convention on Biological Diversity (CBD) and Agenda 21, have called for the world's biodiversity to be inventoried and monitored. Such inventories provide the basic information

for monitoring, which measures changes in the ecosystems (Heywood 1995). The Western Ghats is among the 25 most important hotspots of the world that urgently need efforts for the conservation of biodiversity (Myers *et al.* 2000).

During the faunal inventory of diverse taxonomic groups in and around Pune 18° 32' N 73° 52' E in the Western Ghats, we became interested in mantids and other insects and started looking for various species. We soon realized that there were no institutions nearby where identified collections of mantids were available. We also found that the distribution of Indian mantids was poorly known, as we had collected some species that were not reported from Maharashtra earlier. In fact, many regions of our country, including the Western Ghats, Eastern Ghats and even the highly diverse northeast of India, need fresh explorations. There are hardly any recent references on the mantids of India.

Mantids are predatory insects classified under Order Mantodea. Feeding on grasshoppers, crickets, moths and butterflies, these efficient predators probably control populations of some insects. India has a moderately diverse fauna of mantids with 162 species under 68 genera and 6 families, as indicated in the recent volume on Indian Mantodea (Mukherjee *et al.* 1995, henceforth referred to as the Fauna). About 2,200 species are known worldwide and the Indian share is about 7.36%.

According to the Fauna (Mukherjee *et al.* 1995), 14 genera and 17 species occur in Maharashtra, while two earlier papers (Nadkerny 1965, Mukherjee and Hazra 1983) indicate that there are 25 species under 19 genera. But the Fauna mentions 6 additional species, taking the total tally of mantid species in Maharashtra to 31 (but see below) and the genera to 21. There is also a list of 10 mantid species in the Maharashtra State Gazetteer: Series Fauna (Nadkarni 1974), but since the latest lists are available, this list is not considered here. Another recent paper (Chaturvedi and Hegde 2000) claimed 9 out of 11 species from the Sanjay Gandhi National Park (SGNP, Mumbai) to be new records for Maharashtra. However, these authors have apparently not considered Nadkerny (1965) in which species like Gongylus gongylodes and Creobroter gemmatus have already been reported from Maharashtra. Considering all the above literature, the list of species of Maharashtra needs to be updated and here we are attempting to do so. Needless to say, more surveys will change the final tally.

For the past 3 years, we have been looking for mantids in and around Pune and have collected, dry preserved as per the standard procedure, and identified the various mantids up to species level using the Fauna. All the species were handpicked in the vegetation or when attracted towards fluorescent light. The list of species that we have collected so far (August 2001) is given below. Most species collected from Pune district are first records from this area, as we are not aware of any published list of mantids of Pune. Details of number of specimens studied, their morphometry, etc. will be presented elsewhere. We have studied a minimum of 3 specimens per species, unless otherwise stated. At least one specimen of each species is preserved dry at the Zoology Department, Modern College, Pune.

The list of mantids in our collection:

(* denotes new record for Maharashtra. The collection localities, based on our own work, in and around Pune, are given below each name; locality name in bold denotes a place outside Pune)

INSECTA : MANTODEA

Amorphoscelidae Stal

1. ***Amorphoscelis annulicornis*** Stal
(Dapodi, Kothrud, Modern College Road, **Tadoba**)

HYMENOPODIDAE CHOPARD

2. ***Ephestiasula intermedia*** Werner*
(Pune University,Tamhini, Talegaon, **Satara, Tadoba**)
3. ***Ephestiasula pictipes*** (Wood-Mason)
(Ambegaon, one specimen)
4. ***Euantissa** pulchra* (Fabricius)
(Pashan, Talegaon, Modern College, Kondhwa, A'nagar road)
5. ***Hestiasula brunneriana*** Saussure
(Pune University, Kothrud, Dapodi, Talegaon)
6. ***Creobroter apicalis*** Saussure
(Pune University, Aundh road, Tamhini)

MANTIDAE BURMEISTER

7. ***Didymocorypha lanceolata*** (Fabricius)*
(Chatushringi, Katraj, Talegaon, Kondhwa)
8. ***Dysaules himalayanus*** Wood-Mason
(Talegaon, Taljai hills)
9. ***Humbertiella ceylonica*** Saussure
(Paud, Modern College, Talegaon, Shelewadi, **Kelshi**)
(Aundh, Pune University, Mulshi)
10. ***Heterochaetula fissispinis*** Wood-Mason *
(Pashan, Talegaon)
11. ***Heterochaetula tricolor*** (Wood-Mason)
(Two specimens, Talegaon)
12. ***Schizocephala bicornis*** (Linnaeus)
(Aundh Road, Deccan College Road, Taljai hills, Chatushringi, Kondhwa)
13. ***Hapalopeza nilgirica*** Wood-Mason *
(Kothrud, Talegaon)
14. ***Eomantis guttatipennis*** (Stal)*
(Pune University, Aundh road, Tamhini, Talegaon)
15. ***Deiphobe incisa*** Werner
(Talegaon, one specimen)
16. ***Deiphobe infuscata*** (Saussure)
(Tamhini, Taljai hills)
17. ***Deiphobella laticeps*** (Wood-Mason)*
(Taljai hills, Chatushringi)
18. ***Hierodula (Hierodula) tenuidentata*** Saussure
(Pashan, Modern College, Pune)
19. ***Hierodula (Hierodula) ?ventralis*** Giglio-Tos
(one specimen from Pune)
20. ***Hierodula (Rhombodera) woodmasoni*** Werner *
(Shirwal, one specimen)
21. ***Mantis inornata*** Wemer *
(Dapodi, Talegaon)
22. ***Mantis religiosa*** Linnaeus*
(Dapodi, Pashan, Talegaon)
23. ***Statilia maculata*** (Thunberg)*
(NCL road, Pashan, Talegaon, **Alibag**)
24. ***Phyllothelys westwoodi*** Wood-Mason
(Coll. **Tadoba**, Dist. Chandrapur, one specimen)
25. ***Aethalochroa ashmoliana*** (Westwood)
(Modern College, Erandwana, Dapodi, Talegaon)
26. ***Aethalochroa insignis*** Wood-Mason*
(Coll. **Tadoba**, Dist. Chandrapur, one specimen)
27. ***Toxoderopsis taurus*** Wood-Mason
(Coll. Nannaj, Dist. Sholapur, one specimen)

EMPUSIDAE BURMEISTER

28. ***Empusa guttula*** (Thunberg)*
(Chatushringi, Talegaon)
29. ***Gongylus gongylodes*** (Linnaeus)
(Panshet Dam Road, Sinhagad, Mulshi)

Thus, there are 29 identified mantids in our collection. In addition, there are specimens of 4 unidentified species; one of them is close to *Hierodula (H.) bipapilla* while the other is identified only as *Ephestiasula* sp. There is also a nymph of *Tenodera* sp.; imago is not yet located. There are also a couple of specimens of *Gonypetyllis semuncialis* Wood-Mason from Tadoba, again not known earlier from Maharashtra (sent for additional confirmation). Out of these 29 mantids, 12 are being reported for the first time from Maharashtra. *Hierodula* sp. and *Humbertiella* sp. are difficult to separate as they are poorly differentiated. An extensive and intensive survey must be carried out all over the Western Ghats to settle similar taxonomic questions.

Considering the four publications on taxonomy of Indian Mantodea (Nadkerny 1965, Mukherjee and Hazra 1983, Mukherjee *et al.* 1995, Chaturvedi and Hegde 2000) there are 15 additional species (listed below) known from Maharashtra, which we have not yet collected. Thus, there are at least 48 (33 in collection + 15 from the published records) species of mantids in Maharashtra, although there were probably no surveys specifically for mantids.

A list of mantids known from Maharashtra, but not collected by us so far is as below: (locality names, as mentioned in the papers cited, are given below each name)

HYMENOPODIDAE CHOPARD

1. ***Ambivia popa*** Stal: Andheri, Mumbai: Nadkerny 1965; Ambenali, Satara: Mukherjee and Hazra 1983.
2. ***Creobroter gemmatus*** (Stoll): Santacruz, Mumbai: Nadkerny 1965; Goregaon, Mumbai: Chaturvedi and Hegde 1999.

MANTIDAE BURMEISTER

3. ***Humbertiella affinis*** Giglio-Tos: Goregaon, Mumbai: Chaturvedi and Hegde 1999.
4. ***Humbertiella indica*** Saussure: SGNP, Mumbai: Chaturvedi and Hegde 1999.
5. ***Humbertiella nigrospinosa*** Sjostedt: SGNP, Mumbai: Chaturvedi and Hegde 1999.
6. ***Elmantis nira*** Mukherjee and Hazra 1983: Nira, Satara: Mukherjee and Hazra 1983.
7. ***Elmantis trincomaliae*** (Saussure): Deolali, Nasik: Nadkerny 1965.
8. ***Amantis*** sp.: Andheri, Mumbai: Nadkerny 1965.
9. ***Deiphobe mesomelas*** (Olivier): Locality not mentioned: Mukherjee *et al.* 1995.
10. ***Hierodula (Hierodula) unimaculata*** (Olivier): Salsette, Mumbai: Nadkerny 1965.
11. ***Hierodula (Rhombodera) butleri*** Wood-Mason: SGNP, Mumbai: Chaturvedi and Hegde 1999.
12. ***Mantis nobilis*** Brunner: Ambenali, Pune: Mukherjee and Hazra 1983.
13. ***Euthyphleps curtipes*** (Westwood): Mumbai: Mukherjee *et al.* 1995.
14. ***Paradanuria*** **sp.**: Andheri, Mumbai: Nadkerny 1965.

EMPUSIDAE BURMEISTER

15. ***Empusa pauperata*** (Fabricius): Nasik: Nadkerny 1965.

It is clear from the two lists presented above that, with about 48 species, Maharashtra has a share of 29.62% of all Indian mantids and about 2% of the world's share: both these figures are significant. Some rare species like *Aethalochroa simplicipes*, *Euthyphleps curtipes* and *Toxoderopsis spinigera* are known only from a few localities in Maharashtra (perhaps these are endemics or species of restricted distribution). Presence of *Hestiasula brunneriana* in Mumbai and Pune (Chaturvedi and Hegde 2000, Ghate *et al.* 2001), which was earlier known only from eastern India, also indicates that the distribution records of mantids must be updated. Even *Acromantis montana*, which we recently reported from Karnataka (Western Ghats) (Rane *et al.* 2000), was known earlier from the eastern states only. We therefore feel that more surveys will throw more light on these enigmatic creatures.

We have now started collecting and rearing mantids from oothecae. It is interesting to note that the oothecae are very complex and the structure is perhaps unique to the species or at least to the genus, as suggested by earlier workers (Breland and Dobson 1947). We have observed the much discussed mating and cannibalistic behaviour of the female mantids, as in the case of *Didymocorypha*. We also have colour photographs of many of the live specimens of the mantids reported herein.

It is of interest to note that another species of *Toxoderopsis*, namely *T. spinigera* has not been reported in the past almost 110 years from

any locality in India. The only record is that of the holotype as mentioned in the Fauna.

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February 11, 2002

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36. OCCURRENCE OF SPIDERS *TRIAERIS MANII* AND *TRIAERIS POONAENSIS*, FAMILY OONOPIDAE, IN A BANANA AGROECOSYSTEM IN VADODARA, GUJARAT

(*With one plate*)

During a recent survey in banana fields in and around Vadodara City, Gujarat, to study the spider diversity of the banana agroecosystem, we came across two rare species of Family Oonopidae. Review of literature showed that these two spiders, *Triaeris manii* and

Siliwal, Manju and Dolly Kumar: *Triaeris* sp. PLATE 1

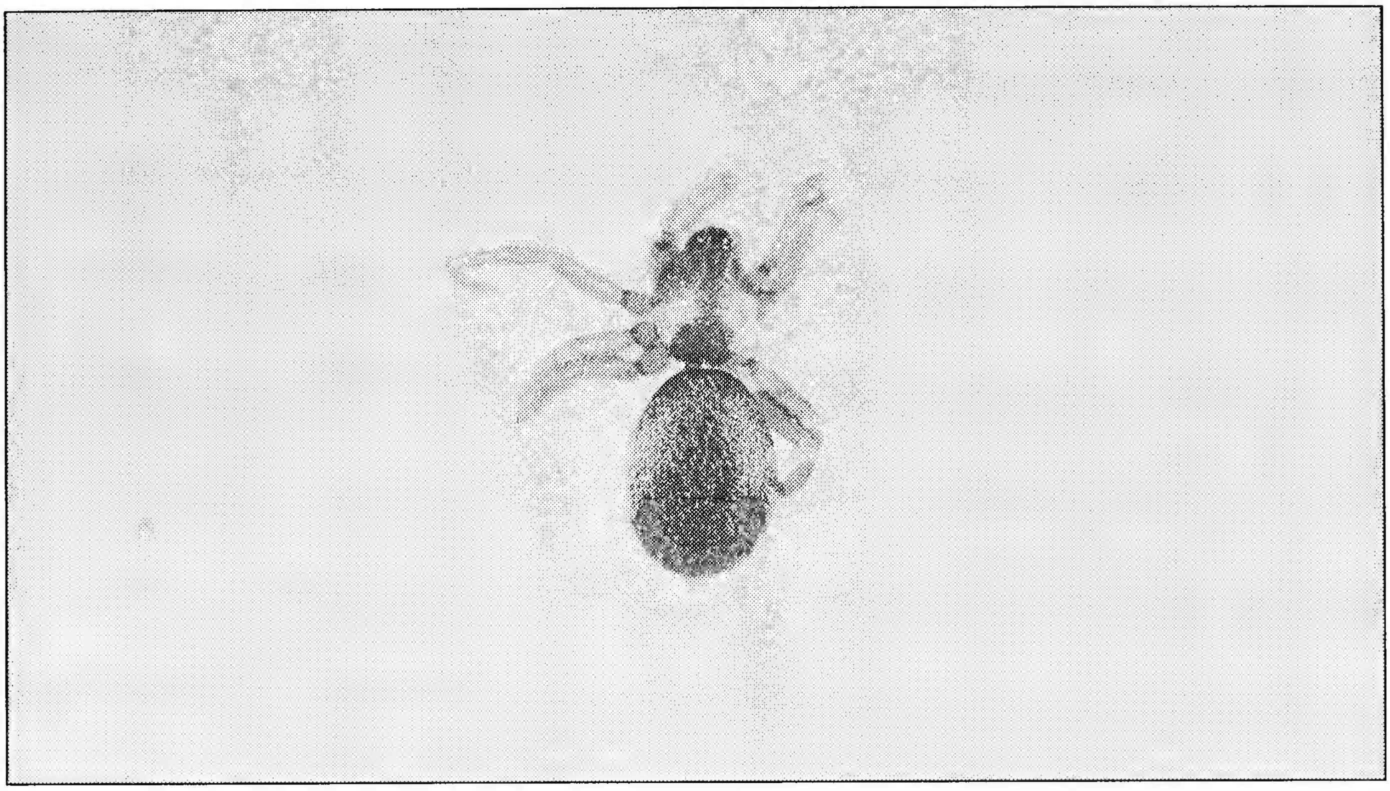

Fig. 1: *Triaeris manii* Tikader & Malhotra (16x)

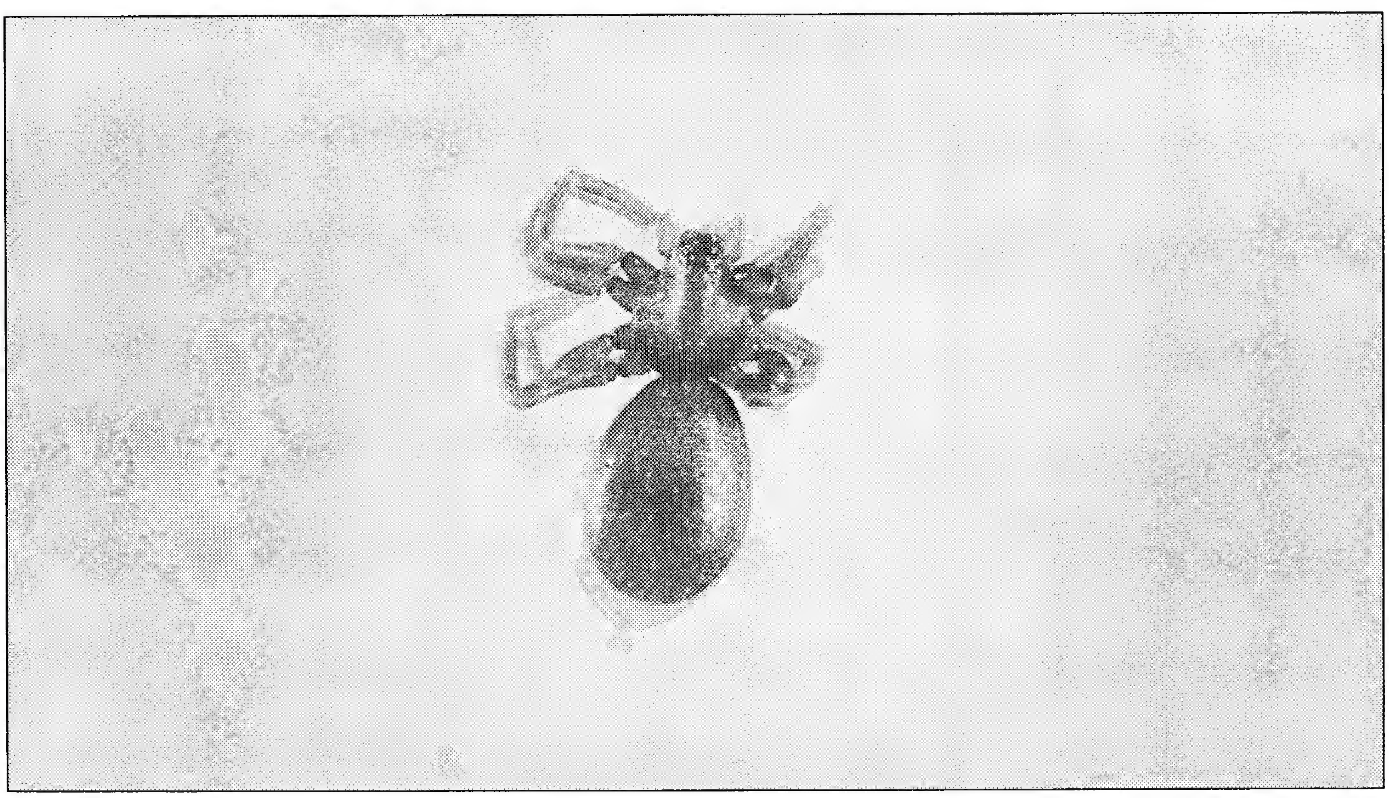

Fig. 2: *Triaeris poonaensis* Tikader & Malhotra (12x)

T. poonaensis were reported only once from the Indian subcontinent by Tikader and Malhotra (1974) from Poona, Maharashtra. This family is little known in India (Tikader and Malhotra 1974), hence it is a significant observation. These spiders mimic the beetles of Family Tenebrionidae. Their cephalothorax, legs and abdomen are reddish-brown. In the present study, these spiders were found inhabiting moist places like decaying leaves of the banana plant, while Tikader and Malhotra (op. cit.) found them under stones and dead bark of trees. Clearly, they prefer moist, dark, damp places, especially in decaying organic matter like dead leaves or the bark of a tree.

Triaeris manii Tikader & Malhotra
(Plate 1, Fig. 1)

Cephalothorax, legs and abdomen reddish-brown. Abdomen nearly elliptical, clothed with fine hairs, scutum on dorsal side complete, on the ventral side incomplete, resembling the elytra of coleopterans. It measures about 2.4 mm in total length, Carapace 1.0 mm in length and 0.7 mm in width, whereas abdomen 1.4 mm in length and 1.2 mm in width. Males, females and juveniles were sighted in the field. They seem to be uncommon in the banana fields. Higher numbers were sighted in January.

Triaeris poonaensis Tikader & Malhotra
(Plate 2, Fig. 2)

Like *T. manii*, these spiders are red, abdomen nearly elliptical, clothed with fine hairs, Dorsal side (except a little posterior part) with conspicuous scutum. Tikader and Malhotra (1974) reported males with complete scutum, unlike females. Ventral side also with scutum extending to base of spinnerets. Scarce in banana fields, only females and juveniles were sighted. Total length *c.* 2.8 mm, Carapace 1.0 mm in length and 0.8 mm in width, abdomen 1.9 mm in length and 1.2 mm in width. Higher numbers were sighted in January, as in *T. manii.*

The occurrence of uncommon spider species in a banana field indicates that the banana agroecosystem provides suitable conditions for breeding of spiders. Detailed studies of spider biology and ecology could be conducted in this agroecosystem.

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TIKADER, B.K. & M.S. MALHOTRA (1974): Studies on some rare spiders of the family Oonopidae from Maharashtra, India. *Oriental Ins. 8(4)*: 495-501.

37. VARIATIONS IN THE WEB OF TWO RELATED SPECIES OF SPIDERS *GASTERACANTHA UNGUIFERA* SIMON AND *GASTERACANTHA HASSELTII* C.L. KOCH

(*With two text-figures*)

Silk plays an important role in the life of spiders. At all life stages, spiders have the ability to release silk (Hansell 1984), which is used not only to spin prey capture webs but also to make

draglines, nests, retreats, cocoon, and for ballooning and encapsulating the prey, among other uses (Kaston 1978, Hansell 1984, Dean and Sterling 1985).

Spiders weave prey capture webs, which vary considerably in shape, size and design, depending on the species and on their age. These variations, however, are common among spiders of the same family.

Members of the Family Araneidae are well known for decorating their orb webs with stabilimentum or with small fuzzy silk balls. Though these modifications in the prey capture webs are known to the genus level, variation at the species level is not sufficiently documented.

A field survey was conducted in 1999-2000 for spider diversity and biology at Jessore Sloth Bear Wildlife Sanctuary (JSBWS), Banaskantha district, Gujarat which encompasses an area of 180.6 sq. km and is part of the Aravalli range that extends into north Gujarat. The forest type, according to Champion and Seth (1968), is Dry Deciduous.

During the study, two species of *Gasteracantha*, *G. unguifera* Simon and *G. hasseltii* C.L. Koch were observed in large numbers. These two species of spiders have small but distinct differences in their morphology and are being reported for the first time from Gujarat state. Nevertheless, what attracted our attention was the remarkable difference they exhibited in the architecture of their webs.

Members of the genus *Gasteracantha* are known to prepare a unique web consisting of a typical orb-web with some small silk balls along the viscid spirals. Later, these silk balls are entangled with debris to form a rounded mass of waste products, the size of a spider (Tikader 1987).

The web of *G. unguifera* (Fig. 1) showed a typical Gasteracanthan design. It had an orb-web in the centre, where the female spider usually rests. Several irregular strands (similar to cobweb) were also found attached to the spiral and radial threads of the main orb-web. These irregular silken threads were seen on all sides of the orb-web over a large area, and their distal ends were attached to a suitable substratum, normally plant twigs or the trunk of a tree. The orb-web and the irregular silken strands were decorated with very conspicuous milky-white beads of silk. The web was noticeable from a distance due to the beads. The diameter of the web was about 35-40 cm, but the area covered by the web was about 1-2 m due to the presence of irregular threads. Webs were always found about 0.9-1 m above the ground. These spiders were sighted throughout the year in the JSBWS, but were relatively less abundant. Males were found in their small separate orb-web (10-14 cm in diameter) that was attached to the large female orb-web with special mating threads. By pulling these threads, the males announce their presence to the female.

The orb-web of *G. hasseltii* (Fig. 2) was found attached to the leaves and twigs of shrubs

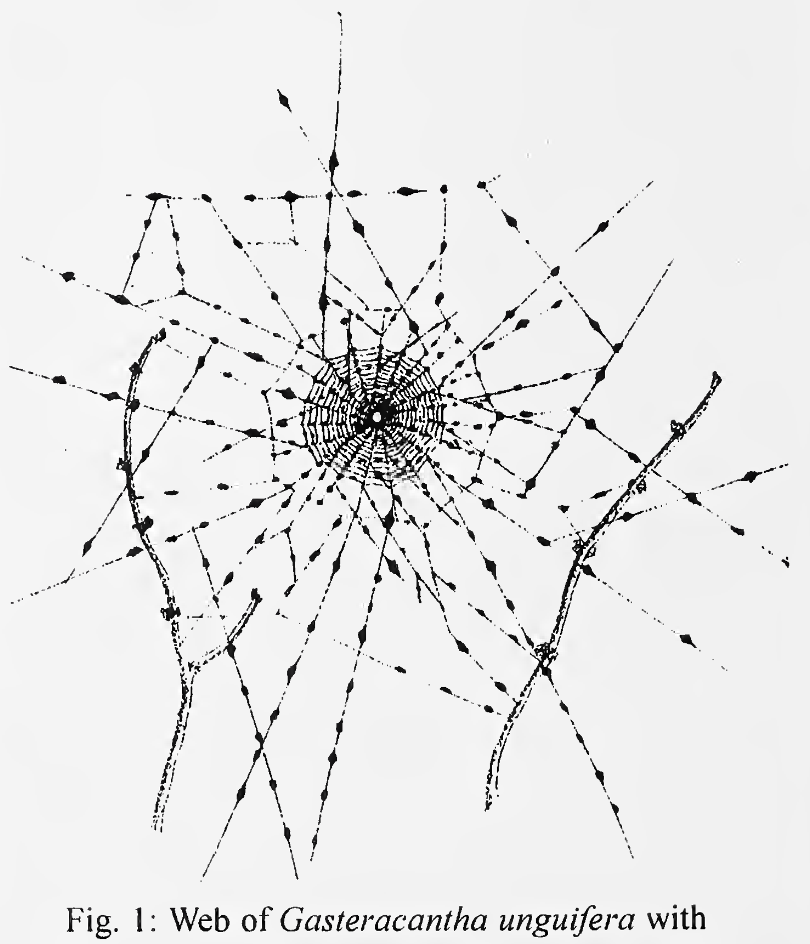

Fig. 1: Web of *Gasteracantha unguifera* with conspicuous silken beads and irregular strands radiating from the main orb-web

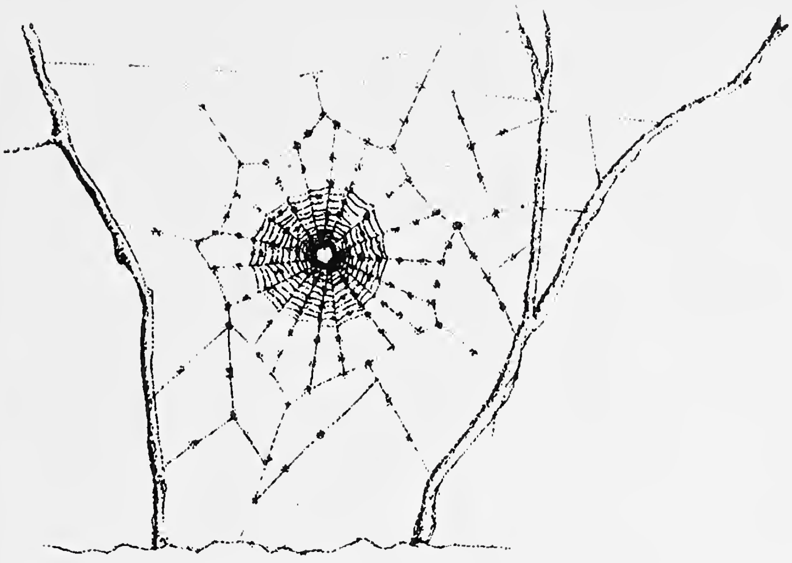

Fig. 2: Web of *Gasteracantha hasseltii* with indistinct fuzzy silk beads

with a few silken strands. The orb-web had very faint silken beads or fuzzy silk on the radial as well as on the spiral threads, which were noticed only after close and careful observation. Moreover, these beads or fuzzy silk were not observed in the webs of subadults. The web was made among the low line vegetation, very close to ground level (3-4 cm above the ground) and its diameter was about 40-56 cm. The size of the web varied considerably, depending on the availability of space. These spiders were sighted from April to November in the JSBWS. Juveniles were seen more frequently in April-May, while adults were found till November.

Tikader (1987) opined that *Gasteracantha* uses the silken beads in their web mainly as a scaring or camouflaging device against predators. *G. hasseltii* make their webs in the lower strata of the forest ecosystem where they are well camouflaged with the ground vegetation against predators. Hence, *G. hasseltii* needs no false silken bead in their web for protection. *G. unguifera* make the web above the ground cover, which make them noticeable to predators. Therefore, they make a number of conspicuous silken beads in the web to misguide their predator. Hence, it can be concluded that *Gasteracantha* species, which occupy various vertical strata in a forest, alter their web patterns probably to suit their surroundings and thus escape predation.

ACKNOWLEDGEMENT

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May 30, 2001

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38. FIRST RECORD OF *JULIA JAPONICA,* A BIVALVED GASTROPOD FROM THE INDIAN OCEAN

(*With three text-figures*)

Bivalved gastropods were first recorded from Indian seas by Pravakar Rao (1965). He recorded *Berthelinia* (*Thamanovalva*) *limax* from the Mandapam camp, Gulf of Mannar, among

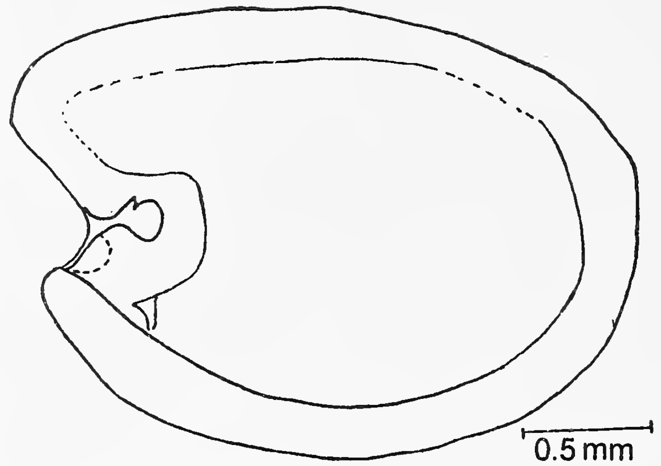

Fig. 1. Right valve *Julia japonica*

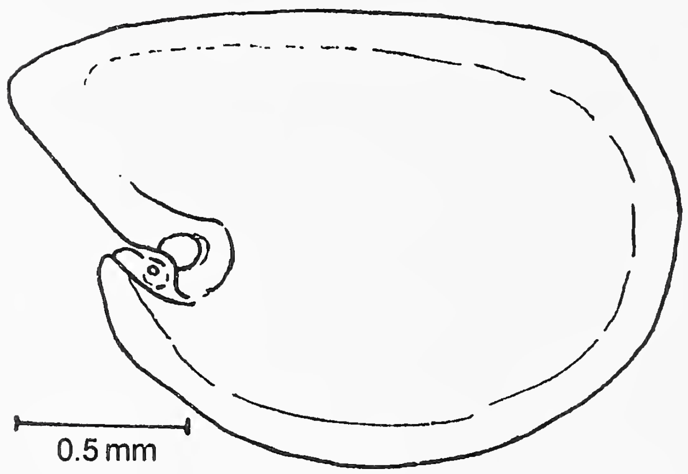

Fig. 2: Right valve *Julia burni*

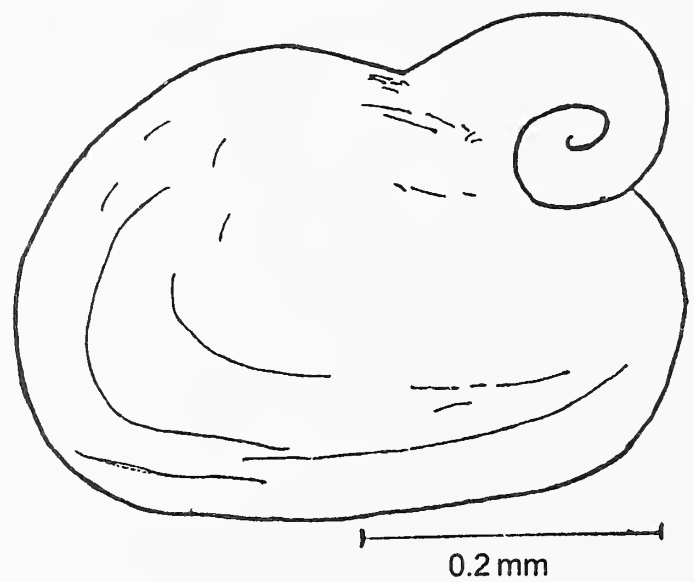

Fig. 3: Left valve *Berthelinia* sp.

green alga *Caulerpa racemosa*. Subsequently, this species along with *B.(T.) ganapatii* and *B.(T.) waltairensis* was reported from the Visakhapatnam coast (Ganapati and Sarma 1968, 1972; Sarma 1975). *B.(T.) schlumbergeri* and *Julia burni* were reported from the Andaman coast (Ganapati and Sarma 1972; Sarma 1975). Recently, Sarma and Chatterjee (1991) reported a *Berthelinia* sp. from the Kovalam beach, Kerala, west coast of India. While engaged in the phytal-faunal associations of *Halimeda opuntia* of Chiriatapu coast of Andaman, a few shells of *Julia japonica* were also encountered.

Spawning habit in *Julia* was described by Kuroda and Habe (1951). Live *Julia japonica* and their feeding and spawning habits were described by Kawaguti and Yamasu (1962, 1966) from the Sea of Japan. The present finding represents the first report of *Julia japonica* from the Indian Ocean.

The shells are 1 to 2.4 mm long. Both right and left valves are thick and heavy (Fig. 1). Each valve is in chordate form. A scar of protoconch is present on the tip of the umbo of the left valve. Besides *Julia japonica* a few shells of *Julia burni* (Fig. 2) and *Berthelinia* sp. (Fig. 3) were also collected.

I thank Dr. Marleen De Troch, Department of Zoology, Marine Biology Section, University of Gent, Belgium for sending copies of literature.

July 18, 2001

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39. OCCURRENCE OF *KLEINHOVIA HOSPITA* L. (STERCULIACEAE) IN MARATHWADA REGION OF MAHARASHTRA STATE

During a floristic and ethnobotanical survey of Nanded district, Marathwada, Maharashtra State, a plant of Family Sterculiaceae *Kleinhovia hospita* L. was detected in the botanical garden of Science College, Nanded. This plant is a common cultivated avenue tree in Mumbai, mostly grown in Parsi holy places. It is a native of Moluccas Islands of eastern Malaysia. Naik (1998) in his FLORA OF MARATHWADA has reported only one specimen in Aurangabad city of Marathwada region, Maharashtra State, but the plant no longer exists in Aurangabad and the authors have confirmed it.

The present authors correctly identified and deposited the voucher specimens in the herbarium of the Postgraduate Department of Botany, Science College, Nanded. It is pertinent to note that recently (Alverson *et al.* 1999) during their cladistic studies of the core Malvales from the ndhF sequence data (ndhF is a chloroplast gene) have confirmed the inclusion of this plant and genus *Kleinhovia*, as suggested long ago by Zebe (1915), in the tribe Byttnerideae and excluded it from Helictereae of Family Sterculiaceae as suggested by Takhtajan (1997). Occurrence of only a single plant specimen in a 64,792 sq. km area is alarming, and deserves attention from the conservation point of view.

April 22, 2000

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40. EXTERNAL MORPHOLOGY OF TESTA IN MANGO *MANGIFERA INDICA* AND ITS VALUE IN THE CULTIVAR CHARACTERISATION OF THE CROP

(*With one plate*)

The significance of SEM studies of testa morphology, at species level, in plant taxonomy has been demonstrated in some angiosperms. However, its value at the level of varieties or

cultivars has not been documented in India and is presented in this communication.

Mangifera indica is an important tropical fruit crop with a large number of natural varieties, which have yet to be documented. There are also cultivated varieties of export quality that earn considerable foreign exchange. The characterisation and classification of the natural varieties are particularly important for their improvement, conservation and use in the propagation of varieties of commercial value. A study on the characterisation of mango varieties, based on testa morphology, has been undertaken in Thiruvananthapuram district, Kerala. The results of studies on three varieties are given below.

Three varieties of *Mangifera indica*, namely Moovandan, Neelum and Banglora, were selected for study. Mango fruit consists of an edible outer part (pulp) overlying the outer seed surface or testa, which is hard and encloses the cotyledons and the embryo. The testa bears conspicuous dichotomously branched veins. The outer and inner surfaces of the testa have structural differences, associated with their location and function. The outer surface is fibrous, while the inner surface is non-fibrous, but both have vicin threads, with randomly placed rounded nodules.

The SEM studies of the outer and inner surfaces of the testa are described (Plate 1, Fig. 1).

Moovandan: Outer testa (Fig. 1a) surface has a cellular base covered by a web of vicin threads carrying intermittent or crowded nodular granules. The inner testa surface (Fig. 1b) is characterised by tiers of parallel plate-like structures. These leafy plates have free tips, no web threads or nodulations.

Neelum: Outer testa surface (Fig. 1c) has a cellular base covered by small trichomes and a web of double layered vicin threads; the lower layer is close netted with dense nodules, while the upper layer is open netted with distantly placed threads. The inner testa surface (Fig. 1d) is disrupted, the cells being saucer-shaped with sparsely nodulated fibrils without any webbing.

Banglora: Outer testa surface (Fig. 1e) has a cellular base covered by plate-like islands covered by a dense mesh of threads with nodules. The inner surface (Fig. 1f) is characterised by a multi-layered lattice pattern, each layer having depressions that are interconnected through thin spinous threads.

It is demonstrated by the study that for each variety of mango tested, the specific characteristics of the outer and inner surfaces of the testa can help to identify a variety. No clear common character can be assigned to the two surfaces except for the vicin threads. The structural differences in the surfaces of the testa could be used in taxonomic studies. The morphology of the outer and inner surfaces of the testa reflect their functions. The outer testa surface holds the pulp, while the inner surface is free and protects the cotyledons and embryo. The degree of needs for such protection is reflected in the structure. The plates had strong fibres in Moovandan, but cellular in Neelum and Banglora.

ACKNOWLEDGEMENTS

We thank the Department of Science and Technology (STEC), Government of Kerala for financial assistance to carry out this work.

June 26, 2000

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Prakashkumar, R. *et al.*: Mango *Mangifera indica* PLATE 1

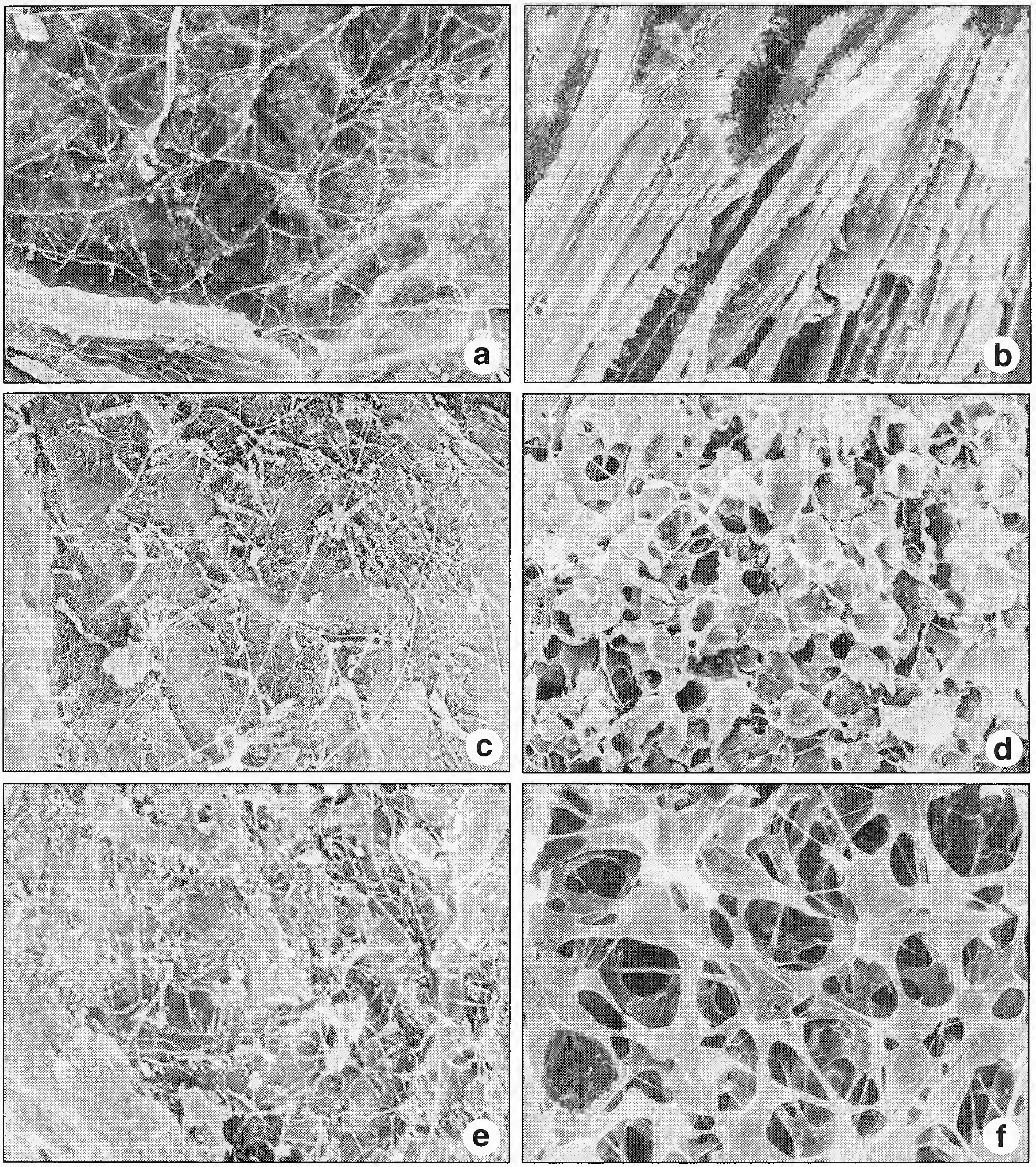
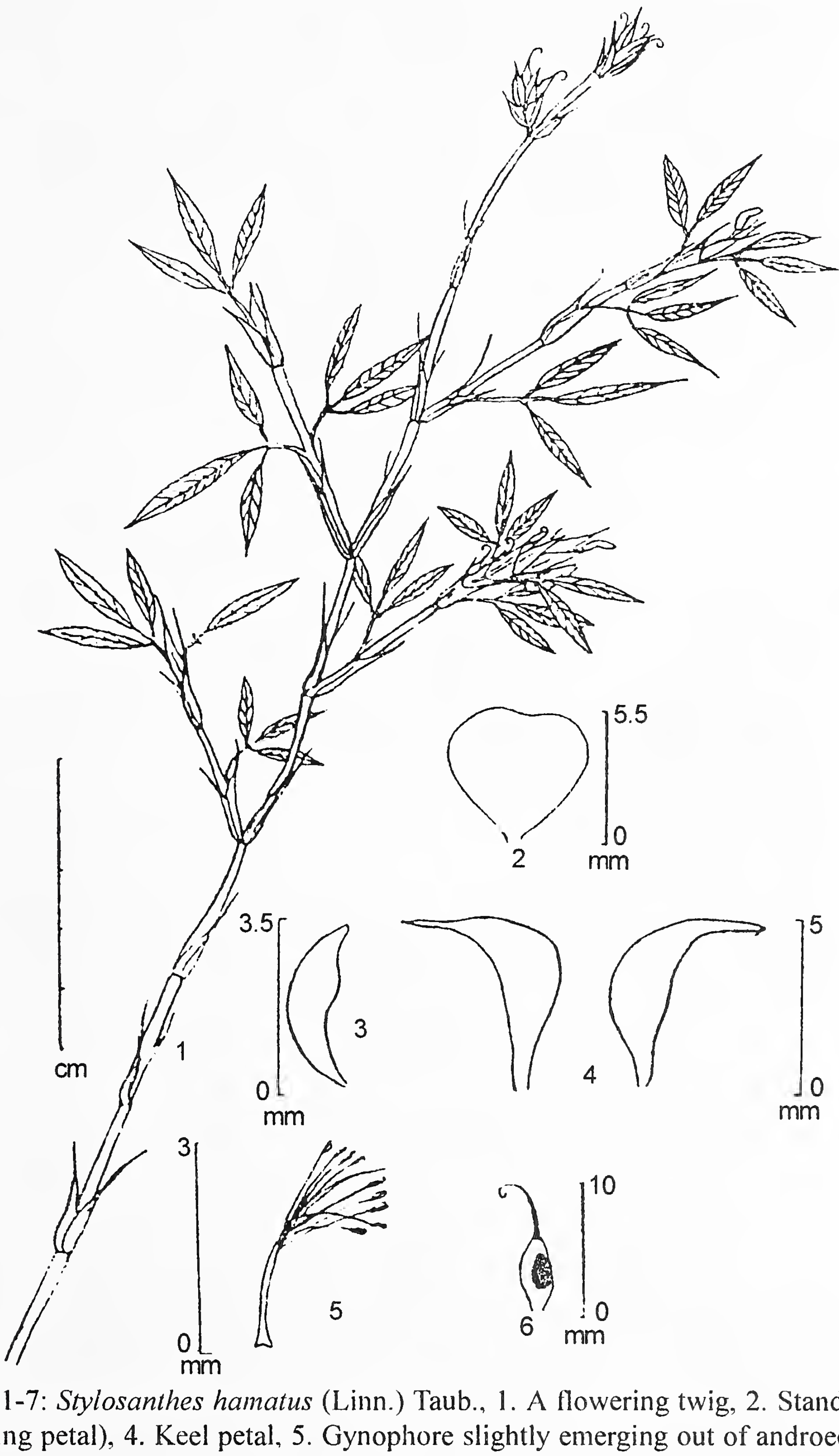


Fig. 1: *Mangifera indica* var Moovandan a. outer testa, b. inner testa;
Mangifera indica var Neelum c. outer testa, d. inner testa;
Mangifera indica var Banglora e. outer testa; f. inner testa

41. *STYLOSANTHES HAMATUS* (LINN.) TAUB. (PAPILIONACEAE), A NEW RECORD TO THE FLORA OF GUJARAT

(*With seven text-figures*)

While investigating the flora of the Barda Hills and their surroundings, an interesting species of *Stylosanthes* was observed near Vijarkhi (Jamnagar) and Ranakandorna (Ranavav) along agricultural fields and roadsides. After critical study, the specimen was



Figs 1-7: *Stylosanthes hamatus* (Linn.) Taub., 1. A flowering twig, 2. Standard petal, 3. Vexillum (wing petal), 4. Keel petal, 5. Gynophore slightly emerging out of androecium sheath, 6. Pod

identified as *Stylosanthes hamatus*, of which there is no published report from Gujarat. A brief description and illustration follows.

Stylosanthes hamatus (Linn.) Taub. in Verh. Bot Brand 32: 22, 1980

Syn. *S. mucronata* Willd., Sp. Pl. 3: 1166, 1802; Beddome, Icon., Pl. Ind. Orient. t. 294, 1871; Baker in Hook. f., Fl. Brit. Ind. 2: 148, 1876; Cooke, Fl. Pres. Bombay 1: 356, 1903; Talbot, Trees Bombay 69, 1902. *S. fruticosa* (Retz.) Alston in Trimen., Handb. Fl. Ceylon 6 suppl. 77, 1931; Nooteboom in Reinwardtia 5: 449, 1961; Verdcort in Kew Bull. 24: 59, 1970. *Arachis fruticosa* Retz, Obs. Bot. 5: 26, 1788. *Hedysarum hamatus* (Linn.) Taub., Syst. Veg. Ed. 10, 1170, 1759 (pro parte, pro typus); Burm. F., Fl. Ind. 167, 1768.

A much branched, low, diffuse, perennial undershrub. Branches terete, stiff, ascending, more or less hairy. Leaves trifoliate, stipules scarious, strongly nerved, adnate to the petiole for half their length, terminating above in 2 spreading teeth. Leaflet 10-18 mm long, elliptic-oblong 4 by 20 mm, or lanceolate, coriaceous, pale green, pubescent on lower surface. Terminal leaflet a little larger than lateral ones, all acute and mucronate at the apex, glabrous above, slightly pubescent, strongly nerved, base subacute; lateral leaflets subsessile, the terminal with a petiole about 4-5 mm long. Flowers solitary or few in sessile terminal heads in the axils of leaf-like stipulate bracts. Bracts persistent, striated, pubescent. Calyx tubular; tube filiform 4-6 mm long, membranous, the upper connate lobes ciliate at the apex. Corolla yellowish-orange 7-9 mm long. Pods flattened, 10-15 mm long, 1-2 jointed, very short, concealed by the persistent bracts, hooked at the apex with the persistent base of the style, joints pubescent with raised veins.

Fl & Fr.: September-February

Present status: Rare

Specimen examined: PSN 221

April 22, 2000

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42. UNUSUAL NUMBER OF CARPELS AND FERTILE STAMENS IN FLOWERS OF *BAUHINIA VARIEGATA* L., LEGUMINOSAE: CAESALPINIOIDEAE

(*With one text-figure*)

My earlier observation on the unusual occurrence of two free carpels in the flowers of *Bauhinia variegata* L. in a collection from Myanmar was included in the publication of Larsen and Larsen in Fl. Males. 12(2): 414. 1996.

Recently, I have again come across a flower of *B. variegata* with two free carpels. The flower was found lying on the ground below a tree of this species on the Prain mound in Division 16 of the Indian Botanic Garden, Howrah. This is the third of six trees of *B. variegata*, counted anti-clockwise from that of a *B. racemosa* Lam. tree on the margin of the circular mound.

In the flower observed, the two free carpels are normal in size, whereas in the collection from Myanmar (Sittang, 8.ii.1905, Coll. ?, herb. acc. no. 137613 - CAL), one flower has two free carpels of normal size and the other two flowers have a normal and a reduced size carpel.

It may be mentioned here that after collecting the flower with two free carpels, I have examined a number of flowers from all the six trees, but all of them either have normal or reduced size carpel.

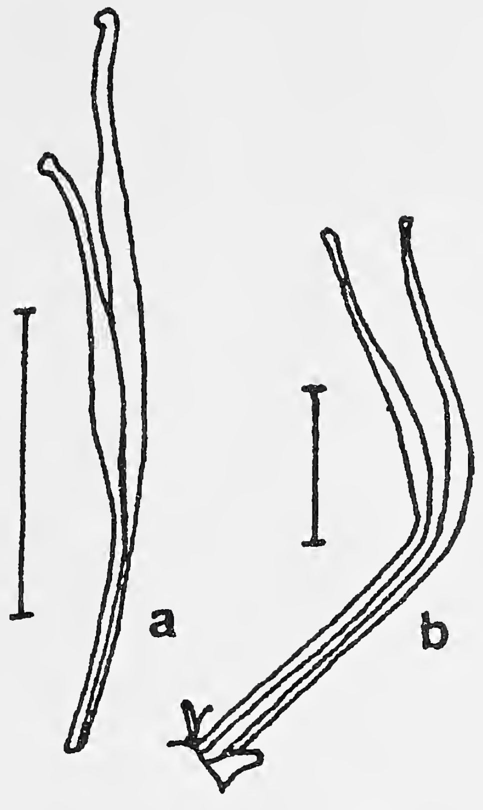

Fig. 1: *Bauhinia variegata* L.: a. Normal and reduced size carpel. — After herb. acc. no. 137613; b. two free carpels of normal size, — After Bandyopadhyay 103. (Scale = 1 cm).

When I was writing this communication, Dr. P.R. Sur kindly drew my attention to a flower of *B. variegata* from his garden at Aakra, Santoshpur, which had not only two free carpels but also ten petals and ten fertile stamens. Moreover, I observed that the spathaceous calyx was shortly bilobed at its apex and each half was made up of five sepals. It seemed to me that two flowers had somehow joined together.

While examining the flower with two free carpels, gathered from the Prain mound, I also observed seven fertile stamens and later found that some of the flowers from the third, fifth and sixth trees in the aforesaid sequence, have four, six or seven fertile stamens. There were also flowers with the usual five stamens. Furthermore, some of the flowers, irrespective of the number of fertile stamens, had two to five staminodes and a reduced stamen of varying size. This interesting variation in the number of fertile stamens and the presence of a reduced stamen has not been recorded earlier in *B. variegata*.

The flowers on all the six trees are reddish-purple and the fertilized ovules develop into well-formed seeds.

The voucher specimens (3.iii.2000, *Bandyopadhya* 103; 14.iii.2000, *Bandyopadhyay* 104; 6.iii.2000, *Sur s.n.*) have been deposited in CAL.

June 26, 2000

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43. *ACTINOSTEMMA TENERUM* GRIFF., CUCURBITACEAE, A NEW PHYTOGEOGRAPHIC RECORD FROM ALIGARH, UTTAR PRADESH

Actinostemma Griff. is a small genus consisting of seven species confined to China (Chakravarty 1959). *A. tenerum* Griff. is the sole representative of this genus in India, with a limited distribution in Assam, Bengal and western Himalayas, and Bahraich, Kheri and Pilibhit in Uttar Pradesh. The above mentioned places in Uttar Pradesh are situated in the terai region and are characterized by humid climate and humus-rich loam soil. The species was recently collected from Aligarh (27° 29' - 28° 11' N, 77° 29' - 78° 38' E). Since this taxon has never been reported from any locality in Uttar Pradesh, except those mentioned above, its occurrence in Aligarh is being reported as a new distributional record.

Actinostemma tenerum Griff. Pl. Cantor. 24.T.3. 1837; Clarke in Hook. f., Fl. Brit. Ind. II 633 (excl. syn.) 1879; Duthie, Fl. Upp. Gang. Pl. I, 382 1969 (Repr edn); Chakravarty, Monograph on Indian Cucurbitaceae, 180, 1939.

An extensive climber with slender, obtusely five-angled branches; younger parts, petiole base and nodes pilose with gland-tipped hairs, tendrils

simple or bifid; leaf-blade sagittately trilobed, leaf-base with a deep sinus, apex acute, margins minutely denticulate or coarsely serrate; male flowers small in large panicle like pendulous inflorescence; sepals and petals cream-coloured, narrow subulate, stamens five, free; female flowers solitary, fruit ovoid-elliptic, softly echinate, circumscissile, without pulp when mature; seeds three, ashy, plano-convex (one seed was noticed with both faces plain) reticulate, margins distinctly grooved.

Fl. and Fr.: September to November.

Exsiccata: Athar s.n. Botany Department Herbarium, Aligarh Muslim University, Aligarh.

Remarks: Rare, grows on moist clay soil on the banks of canals.

April 22, 2000

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44. TWO NEW ADDITIONS TO COOKE'S FLORA OF BOMBAY PRESIDENCY

(*With one text-figure*)

While working on the flora of Chaukul-Ramghat in Savantwadi taluka of Sindhudurg district, two rare angiosperm species were collected. They are presented below with necessary descriptions, line drawings and distribution in the study area.

Emilia scabra (Asteraceae)

(Fig. 1)

DC. Prodr. 6: 303,1838; Wight., Icon. t.1123, 1846; Gamble, Fl. Madras 2: 716, 1921. *E. sonchifolia* DC. var. *scabra* Hook. f., Flora Brit. Ind. 3: 336,1881.

A branched pubescent herb. Leaves radical, scabrous, semiamplexicaul at the base, dentate. Capitulum oblong 1-1.5 cm long and 0.5 cm broad, on forked, slender rachis. Involucral bracts linear, spathulate, 6-7 nerved, nerves faint, yellow, curling outward on drying. Head homogamous. Disc florets many, purple, deciduous; each floret with an inferior, small, rounded triangular ovary. Corolla tube long. Calyx modified into pappus. Pappus many, deciduous, white, consisting of a number of oblong cells, hairy, shining. Corolla with long tube, slightly enlarged at the apex, consists of 5 petals, oval shaped, purple. Stamens 5, epipetalous, filament slender, flexuous. Anthers syngenecious, remain within the corolla tube. Ovary bilocular, slightly flattened, trigonous with long, slender and bifid style; stigma lobes 2, thick, purple, remain within the corolla tube. Achene angled, ribbed, hispid on the angles.

Rare, noticed along the borders of rice fields.

Fl. & Fr.: December.

Distribution: Chakul. Exc. BGG-808 (BLAT).

This species has not been reported since the publication of the FLORA OF MADRAS by Gamble in 1921. This is the first report from Maharashtra and follows a gap of 75 years after Gamble's report. It is also an addition to Cooke's FLORA OF BOMBAY PRESIDENCY.

Cymbopogon nardus L. (Poaceae)

Rendle, var. *luridus* (Hook. f.) Gavade & Almeida comb. nov. *Cymbopogon nardus* (L.) Rendle var. *confertiflorus* (Steud.) Stapf. ex Bor. in J. Bombay nat. Hist. Soc. 51: 905, 1953 & Grass. Ind. 130, 1960. *Andropogon nilgiricus* Hochst. in Hohenacker, Phan. Ind. Or. No. 932, 1851 (nom. nud). *Andropogon confertiflorus* Steud., Syn. pl. Glum. 1: 385, 1854. *Andropogon nardus* L. subsp. *nilgiricus* Hack. in DC., Mon. Phan. 6: 604, 1889; Hook. f., Flora Brit. Ind. 7: 204, 1896. *A. nardus* L. var. *luridus* Hook. f., Flora Brit. Ind. 7: 204, 1896. *Cymbopogon confertiflorus* (Steud.) Stapf., in Kew Bull. 1906: 318, 1906.

Fig. 1: *Emilia scabra* DC., A. Habit, B. Capitulum inflorescence, C. Disc floret, D. L.S. of Disc floret, E. 2 stamens with corolla, F. Enlarged stamen, G. Pistil, H. Involucral bract, I. Collection of Pappus, J. Single Pappus enlarged-Microscopic view, K. Achene, L. Seed

A perennial herb with stout root-stock. Stem tall up to 6 ft (1.8 m), stout, leafy. Leaves long, linear, glaucous beneath; ligule coriaceous. Panicles elongate, rather broad, decompound, branches narrow, sparingly divided. Spike in large crowded fascicles, dark purplish-brown after drying. Spathe cymbiform, hairy, spikelets sessile, lanceolate. Glumes dorsally flat or concave. Keel winged above the middle.

A rare grass noticed on laterite flats.

Flowers: October.

Distribution: Chakul Exc.: BGG – 732. (BLAT).

Sir J.D. Hooker in his FLORA OF BRITISH INDIA in 1879 reported this grass from the Nilgiri hills. N.L. Bor in his GRASSES OF BURMA, CEYLON, INDIA AND PAKISTAN (1960) states that this grass is apparently found in the mountains of Madras.

The Blatter Herbarium, St. Xavier's College, Mumbai has two sheets of this grass, sp. no. 9685 from the Nilgiris, collected by Sedgwick L.J. in June 1916, and sp. no. 230 from Madura collected by Sedgwick L.J. in May 1916.

There is no further report of this grass from Maharashtra by later taxonomists, thus it is a new record for Maharashtra and also an addition to Cooke's flora.

Dr. N.L. Bor followed Stapflew's varietal name *confertiflora* picked up from Steudel's *Andropogon confertiflorus* Steud. However, the rule of priority is not applied outside its own rank and therefore the correct varietal name should be *Cymbopogon nardus* (L.) Rendle var. *luridus* (Hook. f.) Gavade & Almeida, which is proposed here.

ACKNOWLEDGEMENT

I am grateful to my guide Mr. M.R. Almeida, for help in the preparation of this article.

January 12, 2000

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45. ETHNOBOTANICAL USES OF THE POLYGONACEAE IN NEPAL

Family Polygonaceae with about 30 genera and 600 species is well represented in Nepal. Herbs, some shrubs and rarely trees of the family are mainly distributed in the northern temperate region of the globe. So far, 11 genera and 72 species have been recorded from Nepal (Hara *et al.*, 1982). Malick *et al.* (1969) reported a new genus *Eskemukerjea* from Nepal Himalaya. The Family Polygonaceae has also found its way into the homes of the locals because of its varied medicinal properties. These ethnobotanical uses are not well documented, as the use of most species differs from area to area. Hence, a systematic study of the ethnobotanical uses of Family Polygonaceae was undertaken.

Field study was conducted in different parts of the country in the last 15 years. Information on the different uses was noted by interviewing the locals and by making observations. The locals assisted in plant collection and provided indigenous knowledge about their various uses. The information collected was verified by cross checking it at different places on different occasions. The specimens collected and identified by the author are preserved in the Nepal Herbarium and Plant Laboratories, Godawari, Nepal. The plants are listed alphabetically according to their botanical names. Each entry consists of the following sequence: the scientific name; local names (N.-Nepali, T.-Tamang, Th.-Tharu); voucher number; a brief description and the uses.

Aconogonum campanulatum (Hook.f.) Hara; N. Thotane, Raparey ghans; 858-78.

Herb in shady locality. Flowers pinkish-white. Young shoot and leaf are pickled or eaten as vegetable.

A. molle (D. Don) Hara; N. Thotane; 12166.

Herb on moist and open ground. Flowers yellowish. Use same as *A. campanulatum*.

Bistorta amplexicaulis (D. Don) Green; N. Nharkali, Imilachi, Ratanaulo; 8999.

Herb on open and moist ground. Flowers pinkish. Juice of root is used to relieve indigestion and body pain.

B. macrophylla (D. Don) Sojok; N. Chyau phul; 8035.

Herb on open and moist ground. Flowers pink. Juice of root used to treat diarrhoea and dysentery.

B. milletii Lev; N. Mhyakur; 9985.

Herb on open land. Flowers red. Roasted seeds edible and sweet.

B. vaccinifolia (Wall. ex Meisn.) Greene; N. Pulunge jhar; 8959.

Herb on moist rock crevices. Flowers pink. Juice of root used to treat fever.

B. vivipara (L.) S.F. Gray; N. Khalti, Malun; 9859.

Herb on open pasture land. Flowers pinkish. Seeds are pickled, juice of root used for intermittent fever and to treat diarrhoea.

Fagopyrum dibotrys (D. Don) Hara; N. Ban bhar, Barbande, Bhanre, Salsale, Tautha; 9557.

Herb on open and neglected ground. Flowers white. Tender portions are cooked; also considered nutritious fodder.

F. esculentum Moench; N. Phaphar; 11807.

Cultivated herb. Flowers pink. Tender shoot and leaf are cooked; powdered seed used in case of fever.

F. tataricum (L.) Gaertn.; N. Tite phaphar; 9619.

Cultivated herb. Flowers white. Tender shoot and leaf are pickled; seeds are edible; plant is an astringent.

Fallopia pterocarpa (Wall. ex Meisn.) Holub; N. Kalike; 230-75.

A trailing herb in open localities. Flowers yellowish. Tender leaf is cooked.

Koenigia nepalensis D. Don; N. Taunro; 11377.

Herb on moist ground. Flowers white. Tender leaves are cooked, especially during famine.

Oxyria digyna (L.) Hill; N. Kyurba; 8063.

Herb on open hill slopes. Flowers pinkish. Plant is used as a refrigerant.

Persicaria barbata (L.) Hara; N. Aule jhar, Khursani jhar, Semachare ghans, Tote jhar; 12526.

Herb on open and damp places. Flowers white. Tender shoot and leaf are cooked; paste of root is applied to treat scabies (Manandhar, 1990); squeezed plant is used as fish-poison.

P. capitata (Buch.-Ham. ex D. Don) H. Gross; N. Bish maro; 9549.

Herb on moist ground. Flowers pink. Used to treat conjunctivitis, peptic ulcer, boils and wounds, and relieve headache.

P. chinensis (L.) H. Gross; N. Ratnaulo; 12176.

Herb on open and moist ground. Flowers white. Tender leaf pickled. Plant used as a fish-poison.

P. hydropiper (L.) Spach; N. Pire; 11097.

Herb in moist and shady locality. Flowers white. Stem is chewed to treat toothache. Juice of plant is anti-helminthic, carminative and applied on itches. It is poisonous in large amounts to animals and is used as a fish-poison.

P. lapathifolia (L.) S.F. Gray; Th. Bhauka; 6059.

Herb on open ground. Flowers yellowish. Paste of root is used to treat headache.

P. microcephala (D. Don) H. Gross; T. Tungdhap; 12939.

Herb, grows in shady places. Flowers white. Tender shoots and leaves are cooked. Paste of root relieves constipation. Used as fish-poison.

P. nepalensis (Meisn.) H. Gross; N. Raunne; 6822, 8846.

Herb on open ground. Flowers pink. Juice of plant used to heal boils. Plant used for washing

clothes and as nutritious fodder.

P. perfoliata (L.) H. Gross; N. Bakhre aankha, Phaphre jhar; 9561.

Prickly climber. Flowers yellowish. Tender shoots cooked, ripe seeds eaten raw. Juice of plant relieves headache and backache.

P. polystachya (Wall. ex Meisn.) H. Gross; N. Pire; 8977.

Herb on open hill slopes. Flowers white.

P. posumbu (Buch.-Ham. ex D.Don) H. Gross; N. Ratnaulo; 11048.

Herb, grows in moist, shady areas. Flowers pinkish-white. Plant juice used as fish-poison.

P. pubescens (Bl.) Hara; N. Seto pire; 66-92.

Herb on open, moist ground. Flowers pink. Plant is squeezed and spread in stagnant water as fish-poison.

P. punicata (Elliot) Small.; N. Pire khar; 369.

Herb on moist ground. Flowers yellowish. Plant juice used as fish-poison.

P. runcinata (Buch.-Ham. ex D.Don) H. Gross; N. Kapre sag; 1607.

Herb, grows in moist, shady areas. Flowers pinkish. Tender leaves and shoots are cooked.

P. viscosa (Buch.-Ham. ex D. Don) Nakai; N. Rato pire; 2002.

Herb on open ground. Flowers pinkish. Plant juice used to stupefy fishes.

Polygonum plebeium R. Br., N. Sukul jhar; 11923.

Prostrate herb on open ground. Flowers pinkish. Tender shoots are cooked. Juice of root used for diarrhoea, dysentery and bodyache. Paste of whole plant used to treat wound between toes.

Rheum acuminatum Hook. f. & Thoms. ex Hook.; N. Hale; 2975.

Herb on rocky hill slope. Flowers red. Root used as substitute for tea.

R. australe D. Don; N. Padamchal (rhizome), Chulthi amilo (petiole); 6225.

Herb on open, rocky ground. Flowers reddish. Fresh petiole cooked, dried one pickled. Rhizome is purgative, astringent and used in diarrhoea and dysentery (Anonymous 1970).

R. moorcroftianum Royle; N. Padamchal, 2902.

Herb on open, rocky ground. Flowers yellowish. Petioles pickled for use.

Rumex acetosa L.; N. Hale; 6880, 6526.

Herb on open ground. Flowers reddish. Paste of root used to set dislocated or cracked bones.

R. hastatus D. Don; N. Kapu; 659.

Herb on open, rocky ground. Flowers pinkish.

Tender leaves and shoots pickled. Root chewed to relieve throatache. Juice of root used to relieve diarrhoea and dysentery (Manandhar 1995a).

R. nepalensis Spreng; N. Halhale; 42-93.

Herb with stout perennial rootstock. Flowers reddish. Paste of leaf relieves swelling gum; powder of leaf used to treat scabies. Plant relieves body pain. Juice of root used as an anti-helminthic, for cough, cold, and to relieve eye inflammation; pounded root used in diarrhoea and dysentery (Manandhar 1995b). Yellow colour extracted from the root is used for dyeing clothes.

This study recorded 34 species belonging to 10 genera, with diverse ethnobotanical uses in Nepal. These include food, medicine, fish-poison and dyeing. *Persicaria nepalensis* is mixed with water for washing clothes.

Twenty-one species were noted for food value. The seeds of *Bistorta millettii* and *B. vivipara* and the petiole of *Rheum australe* and *R. moorcroftianum* are pickled. Tender shoots and leaves of 16 species are cooked. Two cultivated species, *Fagopyrum esculentum* and *F. tataricum* are important items of food for individuals living in the temperate and sub-alpine belt of the country. Powdered roots of *Rheum acuminatum* serve as a substitute for tea, which is relished by the locals, though the taste differs from the original tea.

Thus the plants contribute greatly to rural health care. Manandhar (1989) has recorded piscicidal properties in *Persicaria chinensis*, *P. microcephala*, *P. posumbu* and *P. punicata*.

The ethnobotanical uses of Family Polygonaceae call for scientific evaluation of folk claims and intensive field work among unexplored ethnic groups, areas and plant diversity of the country.

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46. A NEW NAME FOR *DIOSCOREA GLABRA* VAR. *HASTIFOLIA* PRAIN ET BURKILL FROM THE ANDAMAN AND NICOBAR ISLANDS, INDIA

(*With one text-figure*)

Dioscorea serpenticola A. Hoque & P.K. Mukherjee nom. et stat nov. is an endemic species to the Andaman Islands. It was first collected by C.G. Rogers in 1904 from Rutland, South Andaman. Later, J.L. Ellis collected it from Saddle Peak, North Andaman in 1987. D. Prain and I.H. Burkill named it *Dioscorea glabra* var. *hastifolia* Prain et Burkill in 1914, based on the collections of C.G. Rogers.

Dioscorea serpenticola A. Hoque & P.K. Mukherjee nom. et stat. nov. (Fig. 1).

Type: South Andaman, Rutland, 19.v.1904, C.G. Rogers 278 (Holotype, CAL).

Syn.: *D. glabra* var. *hastifolia* Prain et Burkill, Journ. Asiat. Soc. Beng. ns. 10: 37, 1914; Knuth in Engl. Pflanzenr.87 (IV-43): 277, 1924., (non *D. hastifolia* Ness, Lehm., Pl. Preiss. 2: 33, 1848).

D. elegans Ridl., *D. oryzetorum* Prain et Burkill et *D. glabra* Roxb. similis caule dextrorsum volubile, Lamina coriacea, spico masculo 2 cm longo, alabastro masculo globoso, diplotegio latiore quam longo, seminis ala cingenti, sed differt a *D. elegans* Ridl. et *D. oryzetorum* Prain et Burkill venatione campylodromo, nervibus 7, lamina hastata, et differt a *D. glabra* Roxb. foliis alternis, lamina petiolis perlongiora, diplotegiis parvioribus, spico masculo axillari.

Tuber 1.5-3 cm, hard, globose, woody knot at base of stem, bearing tuft of horizontal long roots, superficially buried. Bulbils not known. Stem right twining, terete, glabrous, unarmed, slender, faintly ridged. Leaves simple, alternate, petiole 1-2 cm long, shorter than lamina (lamina:petiole = 5:1)

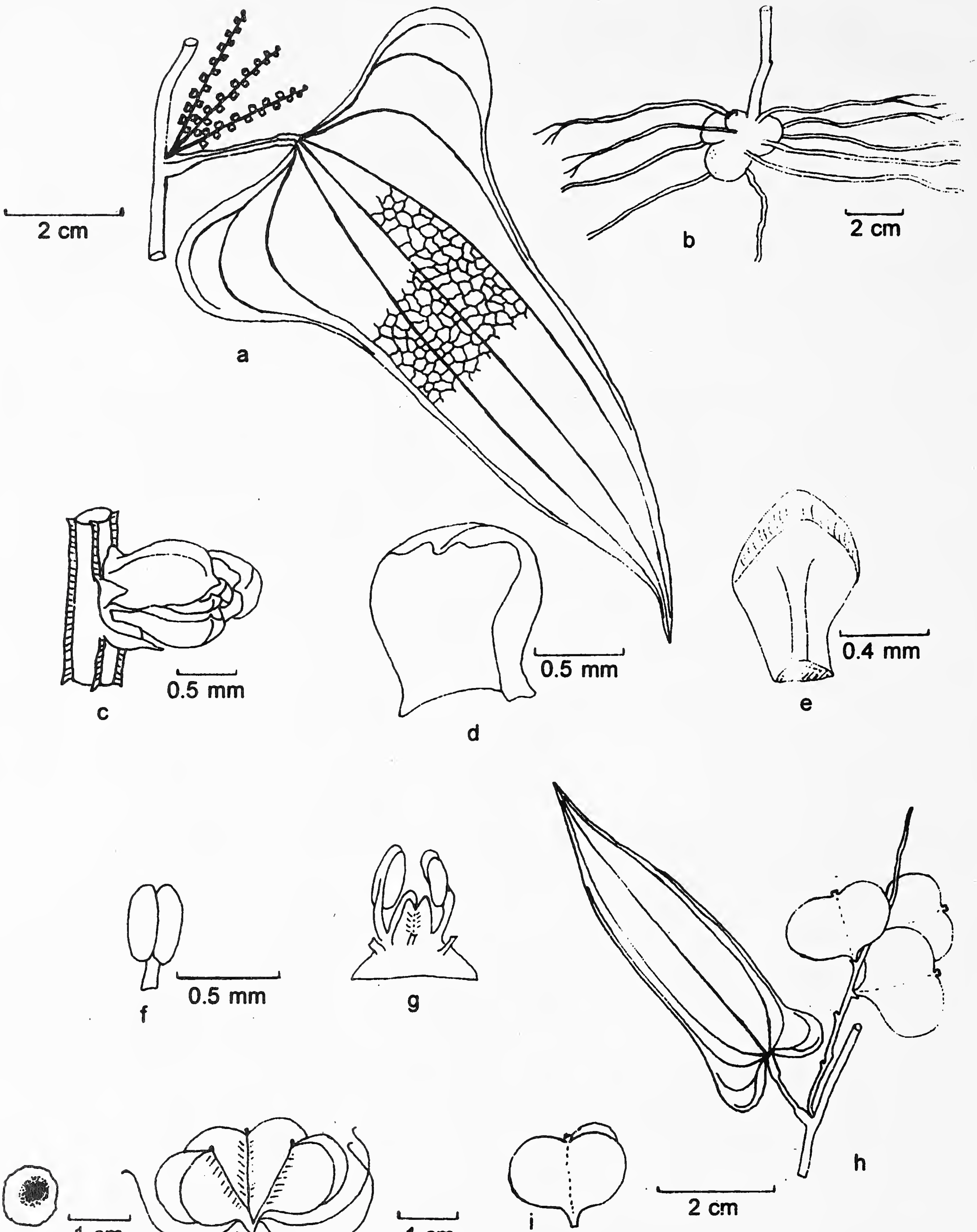

Fig. 1: *Dioscorea serpenticola* A. Hoque & P.K. Mukherjee, a. Habit, b. Underground woody knot, c. Part of male inflorescence, d. Outer perianth, e. Inner perianth, f. Single stamen, g. Position of stamens with pistillode, h. Twig with fruits, i. Single diplotegia, j. Dehiscence of diplotegia, k. Single seed. (a-g: Ellis, J.L. 12719; h-k: Rogers, C.G. 278)

with apical and basal pulvini; lamina 6-10.8 x 3-6 cm, hastate, apex acuminate, base broad or shallow cordate, texture coriaceous, venation palmate, convergent, reticulate (campylodromous), 5-7 nerved, midrib and the first pair of secondary veins reach up to acumen, tertiary veins irregularly branched, forming a network, nerves faintly prominent on abaxial surface, glabrous on both surfaces.

Male inflorescence axillary, somewhat stout, simple spike, arising in fascicles directly from leaf axils, sometimes singly on short flowering branch, 5-7 cm long. Rachis slightly drooping, terete, winged or ridged, glabrous, straight, 0.7-2.8 cm long, bearing 14-20 solitary alternate flowers at 0.5-1 mm intervals.

Male flowers globose or elongate-globose, sessile, with broad base, 1-1.2 x 1 mm, larger than bract, thalamus slightly convex. Bract 1, 0.7-1 x 0.7 mm, anterior, sessile, concave, ovate, apex acuminate-cuspidate, base broad thin, mem-branous. Bracteole 1, 0.5 x 0.5 mm, sessile, lateral, ovate, flat, apex acute, base constricted. Perianths 6, in two whorls (3 + 3), glabrous, polyphyllous, somewhat open; outer 3 obovate, concave, apex acute or obtuse, base broad, margin wavy, 1.1 x 0.85 mm; inner 3 spathulate, hooded, 0.8 x 0.75 mm. Stamens 6, in two whorls in alternate series, all fertile, 0.5 mm long, filament 0.2 mm long, stout, anthers 0.3 mm long, introrse, connective narrow; outer 3 alternate to inner perianth, inner 3 alternate to pistillode ridges inside and opposite to inner perianth outside. Pistillode triridged, apex emarginate-cleft, 0.2 mm long, situated at the centre of torus.

Female inflorescence axillary, simple spike, erect, rachis angular, ridged, stout, 5-7 cm long, bearing 7-16 solitary alternate flowers at 0.3-0.6 cm intervals.

Infructescence erect or semi erect, rachis stout, fruits overlapping, 3-9 fruits on a rachis. Diplotegia not recurved, stipitate (stipe 0.5-0.6 mm), triwinged capsule, with marcescent perianth cup at apex and marcescent bract and bracteole at base, capsule almost rounded (1.5-1.8 x 1.9-2 cm), apex emarginate, base truncate, margins curved. Dehiscence loculicidally septifragal with separation of 3 ribs. Seeds 1 cm diameter, rounded with wing all round, dark maroon.

Distribution: Andaman and Nicobar Islands: South Andaman, Rutland; North Andaman, Saddle Peak.

Fl.: September to October.

Fr.: October to January.

Specimens examined: INDIA - South Andaman, Rutland, 19.v.1904, C.G. Rogers 278 (CAL, type); North Andaman, Saddle Peak, 500 m, 16.x.1987, J.L. Ellis 12719 (PBL).

Dioscorea serpenticola is readily separated from related species by alternate leaves, lamina hastate, much longer than petiole, base truncate, venation campylodromous, 7- nerved; male spikes directly on stem axil; diplotegia small, broader than long, dehiscence by rib separation. We feel that the morphological differences cited above are adequate to recognise this as a distinct species.

The specific epithet *hastifolia* is preoccupied by the existence of *D. hastifolia* Nees, Lehm. Pl. Preiss. 2: 33, 1848. So the name *Dioscorea hastifolia* cannot be applied, being a later homonym, which is illegitimate (Art. 53 of ICBN, Tokyo, 1994). So the above new binomen is proposed.

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47. *STYLIDIUM TENELLUM* SWARTZ (STYLIDIACEAE), A NEW RECORD FOR MAHARASHTRA STATE

(*With a text-figure*)

The genus *Stylidium* Sw. is represented in India by two species, namely *S. tenellum* Sw. and *S. kunthii* Wall. *S. kunthii* is confined to Eastern India, whereas *S. tenellum* is reported from Uttar Pradesh (Babu 1977), Bihar and Orissa (Haines 1921-24), Madhya Pradesh (Mukherjee 1984 and

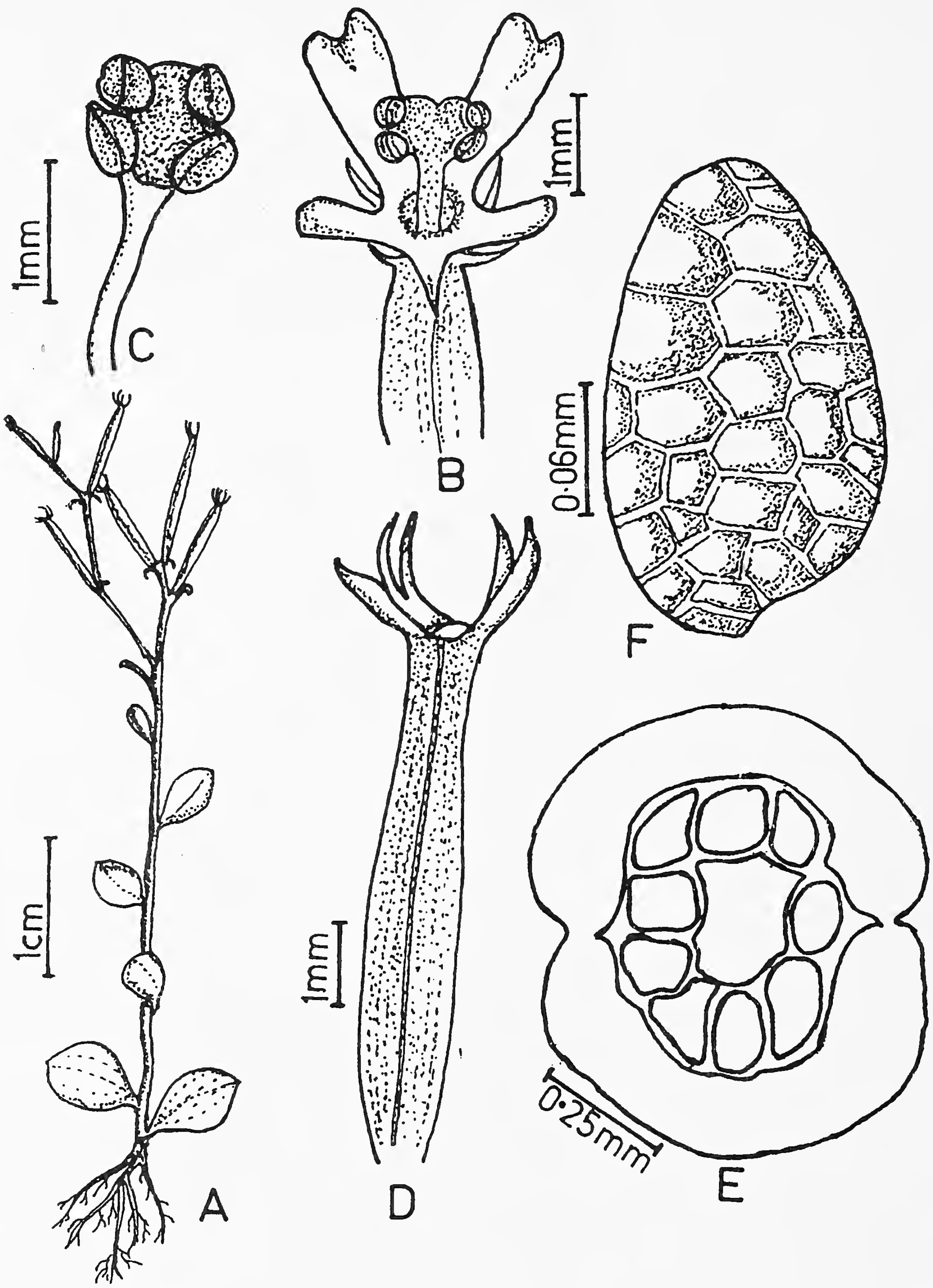

Fig. 1: *Stylidium tenellum* Sw., A. Twig, B. Flower, C. Gynostemium, D. Mature capsule, E. T.S. Capsule & F. Seed showing surface ornamentation

Verma *et. al* 1985) and Karnataka (Bhaskar and Kushalappa 1991). However, there is no record of its occurrence in Maharashtra State so far. The author is reporting for the first time the occurrence of *S. tenellum* Sw. from Maharashtra State.

During the survey of wetlands of Gondia district, Maharashtra State, the author collected *Stylidium tenellum* Sw. from Borkanhar locality of Amgaon tehsil.

The voucher specimen has been deposited in the herbarium, Department of Botany, Bhawabhuti Mahavidyalaya, Amgaon, Gondia district, Maharashtra.

The diagnostic characters, locality, field number and notes are given below.

Stylidium tenellum Sw. Ges. Naturf. far. Berlin 1:51, t.2,f. 3,1807 (non R. Br.1810); Clarke in Hook f., F.B.I. 3.420.1881; Haines, Botany of Bihar & Orissa 4: 499.1921-1924; Babu, Herb. Fl. Dehra Dun, 291, 1977; Mukherjee, Fl. Pachmarhi & Bori Reserve. 271.1994; Verma *et. al*, Fl. Raipur, Durg & Rajnandgaon. 207.1985; Bhaskar & Kushalappa, J. Bombay. nat. Hist. Soc. 88(3): 465.1991.

Annual, erect, glabrous, slender herb, up to 10 cm high, normally branched, branches filiform, stem dark purple or brown; leaves alternate, sessile, lanceolate-oblong or obovate-spathulate, *c.* 0.8 mm long, obtuse, entire, 3-nerved; basal ones in rosette, upper ones passing into bracts; flowers minute, sessile, 2-3 in cymes, zygomorphic, epigynous, rose-purple; sepals 5, linear, subequal, spreading, persistent in the fruit; corolla bilabiate, purple or pink, lower three lobes minute, upper two spathulate, prominent and ray-like; corolla tube minute; stamens 2, filaments adnate to the style into an elongate geniculate column which is inclined to one side; anther lobes 4; stigma hairy; ovary inferior; capsule linear 10-12 mm long, pubescent, valves united at both ends; seeds minute, brown, angled.

Fl. and Fr.: October-January.

Ecology: Occasional, along the edges of tanks in open grassy places, found on sandy loam.

Specimen Examined: Borkanhar, Amgaon, Bhuskute 205, 19.xi.1998.

Associated Taxa: *Utricularia caerulea* Linn., *Lindernia ciliata* (Colsm.) Pennell, *Xyris pauciflora* Willd., *Diplacrum caricinum* R. Br. This taxon is easily mistaken at first sight for *Lindernia*, but may be distinguished by its peculiar gynostemium and inferior ovary.

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48. ADDITIONS TO THE GRASS GENERA OF MAHARASHTRA

(*With two text-figures*)

Intensive and extensive studies over the last 10 years on the grass flora, Family Poaceae, of southwestern Maharashtra (comprising five districts namely Kolhapur, Ratnagiri, Sangli, Satara and Sindhudurg) have yielded two unrecorded grass genera from the State. Full

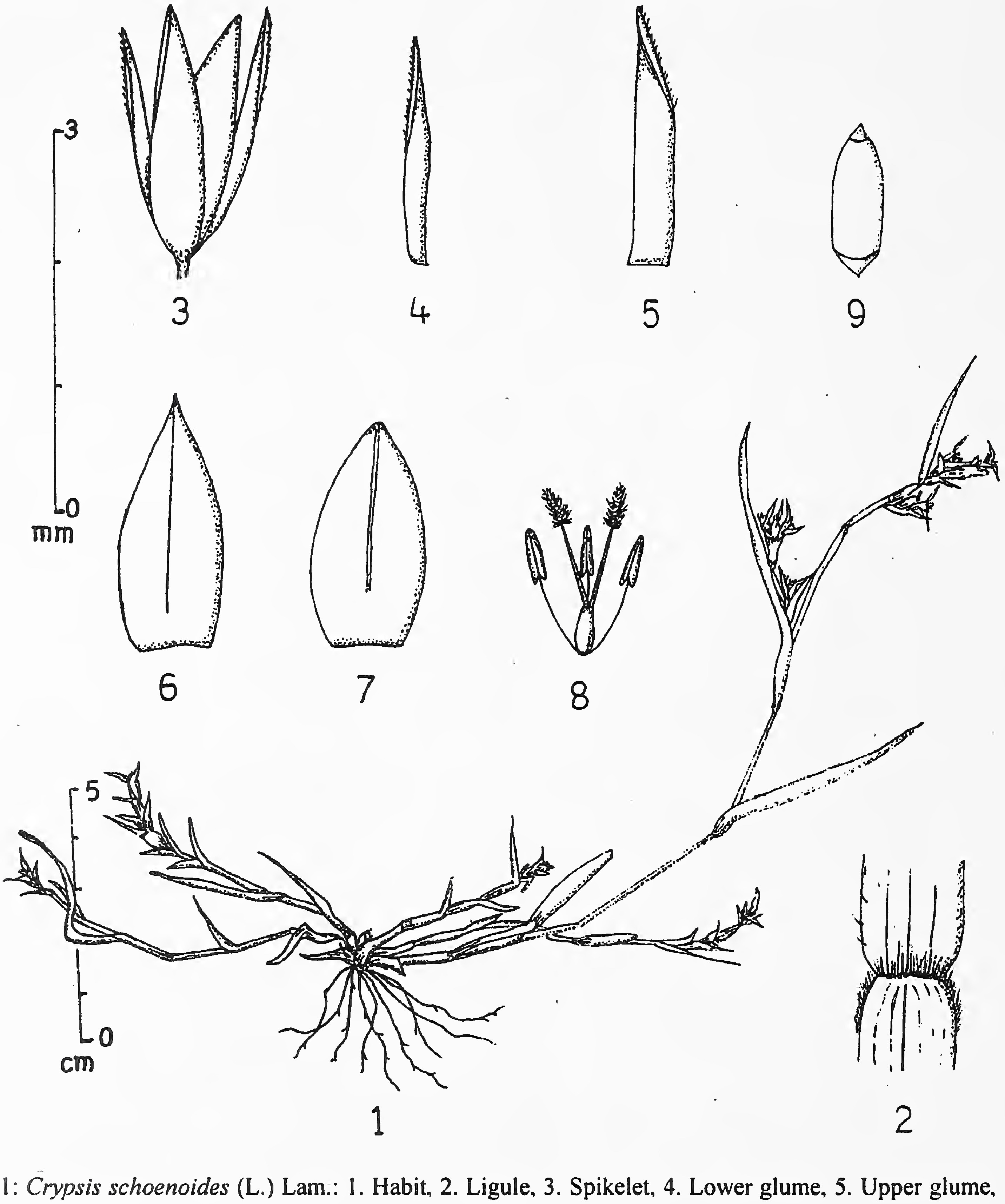

Fig. 1: *Crypsis schoenoides* (L.) Lam.: 1. Habit, 2. Ligule, 3. Spikelet, 4. Lower glume, 5. Upper glume, 6. Lemma, 7. Palea, 8. Stamens & Pistil, 9. Caryopsis

descriptions and illustrations are provided for each genus in this paper. Voucher specimens have been deposited in the Herbarium of Shivaji University, Kolhapur.

1. ***Crypsis schoenoides*** (L.) Lam. Tab. Encycl. Meth. Bot. 1: 166. 1791; Bor, Grass. Bur. Cey. Ind. Pak. 622. 1960. *Phleum schoenoides* L. Sp. Pl. ed. 1: 60. 1753. *Heleochloa*

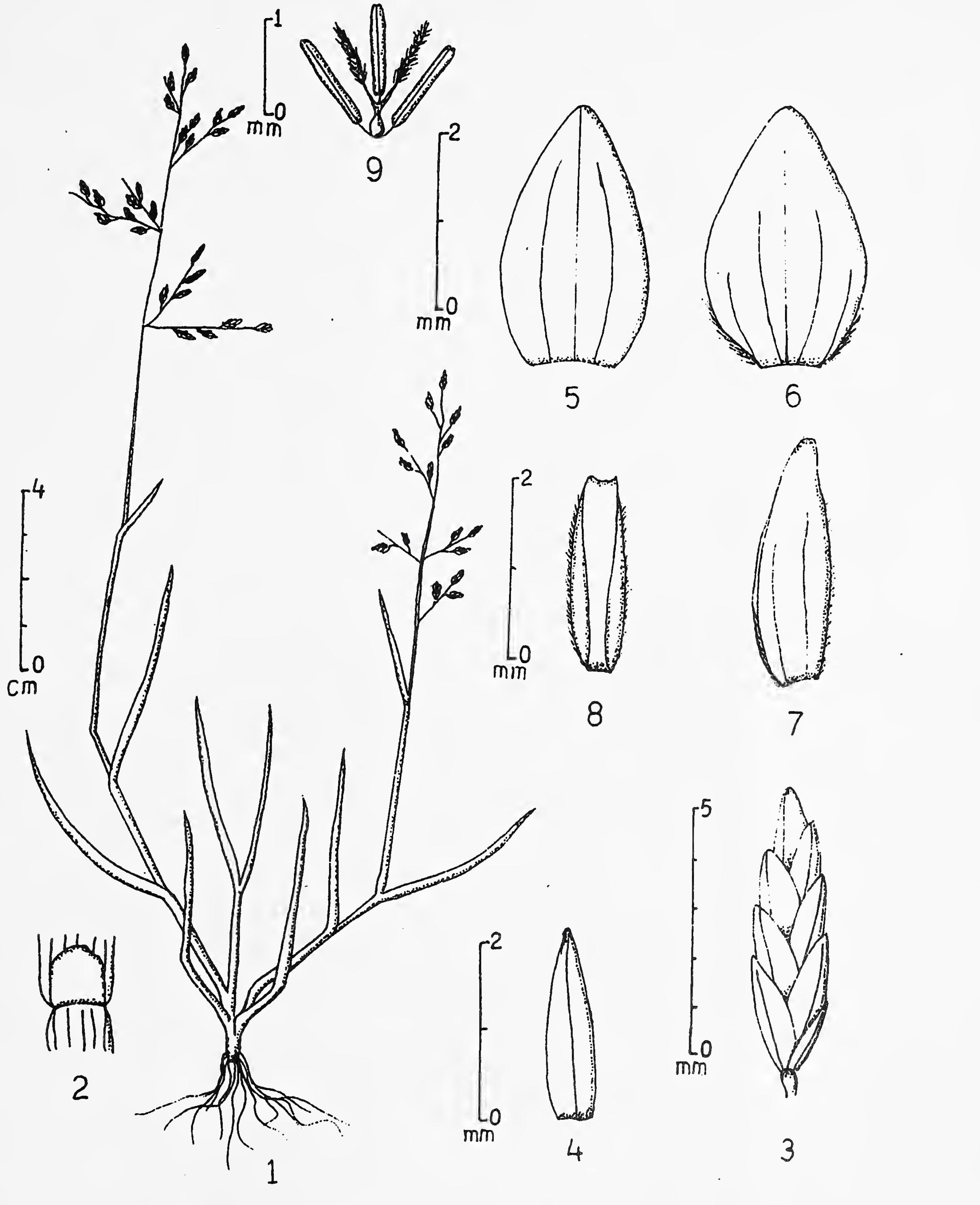

Fig. 2: *Poa annua* L.: 1. Habit, 2. Ligule, 3. Spikelet, 4. Lower glume, 5. Upper glume front view, 6. Upper glume back view, 7. Lemma, 8. Palea, 9. Stamens & Pistil

schoenoides (L.) Host. Icon. Gram. Austr. 1: 23. 1801. Hook. f. Fl. Brit. Ind. 7: 235. 1896. Fig. 1.

Annual or perennial herbs. Culms tufted, terete, 3-18 cm long, creeping, decumbent; nodes glabrous. Leaves: sheaths compressed, keeled, striate, margins hyaline, ciliate near the apex, ligule ciliate, 0.8-1 mm long, blades linear-lanceolate, 0.5-5 x 0.1-0.4 cm, sparsely hispid with tubercle based hairs, margins scaberulous, apex acute. Panicles compressed, compact, short, spicate, ovate-oblong, 0.4-0.8 cm long, concealed in the sheaths, rachis slender, pedicels short. Spikelets linear-lanceolate, 2-3 mm long, laterally compressed. Lower glume membranous, linear, 2-2.2 mm long, 1-nerved, keeled, keels ciliate, apex acute. Upper glume membranous, ovate-lanceolate, 2.4-3 mm long, 1-nerved, keeled, keels ciliate, apex acute. Lemma membranous, ovate-lanceolate, 2.4-3 mm long, 1-nerved, keeled, apex acute. Palea hyaline, ovate-oblong, 2.2-2.5 mm long, nerveless, keeled, apex obtuse. Lodicules 2, minute. Stamens 3; anthers 0.4-0.6 mm long. Grain oblong, 1.3-1.6 mm long.

Rare near moist places.

Fl. & Fr.: September-December.

Specimen examined: *Patil* 8987, Satara city, Satara district.

2. ***Poa annua*** L., Sp. Pl. 68. 1-1753; Hook. f., Fl. Brit. Ind. 7: 345. 1896; Bor Grass. Bur. Cey. Ind. Pak. 547. 1960. Fig. 2.

Annual herbs. Culms tufted, terete, erect or ascending. 5-30 cm high, simple or sparingly branched; nodes glabrous. Leaves: sheaths subcompressed, glabrous, ligule membranous, 1.5-3.5 mm long; blades flat, oblong-lanceolate. 1-10 x 0.1-0.5 cm, glabrous, margins scaberulous; apex acute. Panicles pyramidal, 2.5-7 cm long; rachis slender, glabrous, branches filiform. Spikelets ovate-oblong, 3.5-7 x 1-3 mm long, 3-6 flowered. Lower glume chartaceous, lanceolate, 1.5-2 mm long, 1-nerved, glabrous; apex subacute. Upper glume chartaceous, oblong-elliptic, 2-3 mm long, 3-nerved, glabrous; apex obtuse. Lemma chartaceous, elliptic-oblong, 2-3 mm long, 5-nerved, keeled, keels ciliate; apex obtuse. Palea chartaceous, oblong-lanceolate 1.5-2.2 mm long, keeled, keels ciliate; apex toothed. Lodicules 2. Stamens 3; anthers 0.5-1 mm long.

Rare, found growing in strawberry plantations at high altitudes.

Fl. & Fr.: August-November.

Specimen examined: *Salunkhe* 8900, Mahabaleshwar, Satara district.

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49. TOXIC PHANEROGAMIC PLANTS OF MANIPUR

Manipur, a tiny state in northeast India, has luxuriant natural flora and fauna. The indigenous people of Manipur have been using natural products of plants for food, medicine and house construction. Primitive man, in his quest for plants that could provide food, after trial and error, identified poisonous plants. Many medicinal plants are also poisonous. The effect

varies, depending upon the individual and the dose taken. However, highly poisonous plants are those that induce fatal consequences immediately, or by the cumulative action of the toxic content even when a small quantity is taken (Long 1992). Toxic plants may be classified broadly into three main groups (Thothathri 1985).

i) Poisonous to men and livestock

ii) Poisonous to fishes

iii) Insect repellent plants

Poisonous plants are probably responsible for greater losses in farm livestock than is commonly believed. Sometimes they may cause illness and death of human beings, particularly villagers who mainly depend on wild plants for food. From the herbal medicinal practitioners (Maibas), the traditional use of arrows poison-tipped with extracts of *Arum maculatum* L., use of rootstock for poisoning wild animals and fowls in hunting or for selfprotection, can be traced to the tribal population (Sinha 1996). Mass food poisoning of some villagers due to consumption of wrong combinations of otherwise edible wild plants as vegetables, also reveals the poisonous nature of some plants.

Many villages, mainly the valley and some parts of the hills of Manipur were surveyed by us for poisonous plants. The information on the toxic effects of the plants was obtained through village elders and priests commonly known as Maibas (herbal practitioners). During the survey, the plant parts having toxic effects were collected and preserved on herbarium sheets. Species were identified with the help of the Botanical Survey of India, Shillong, Meghalaya. The Latin names, local names and family of the collected plant species are listed in Table 1.

TABLE 1

POISONOUS PHANEROGAMIC PLANTS OF MANIPUR

Sl. No.	Latin name	Local name	Family
1.	*Abrus precatorius* Linn.	Chaning (M)	Malvaceae
2.	*Acacia pruinescens* Kurz	Te-bam (Naga)	Mimosaceae
3.	*Aconitum nagarum*	—	Helleboraceae
4.	*Acronychia pedunculata* Miq.	Khanghailak (Kuki)	Rutaceae
5.	*Adenium obesum*	—	Lauraceae
6.	*Aegle marmelos* Correa ex Roxb.	Heirikhagok (M)	Rutaceae
7.	*Agave americana* Linn.	Kewa (M)	Agavaceae
8.	*Antidesma bunius* Spreng	—	Euphorbiaceae
9.	*Arisaema tortuosum* Schott	Lincheishu (M)	Araceae
10.	*Asclepias curassavica* Linn.	Krishnachura (M)	Asclepiadaceae
11.	*Begonia palmata* D. Don	Banhang (Rongmei)	Begoniaceae
12.	*Begonia picta* Smith	Banhang (Rongmei)	Begoniaceae
13.	*Blumea balsamifera* Linn.	Langthrei (M)	Asteraceae
14.	*Blumea densiflora* DC	Karpoor (M)	Asteraceae
15.	*Commelina padulosa* Bl.	Wangden khoibi (M)	Commelinaceae
16.	*Cannabis sativa* Linn.	Ganja (M)	Cannabinaceae
17.	*Catharanthus roseus* Linn	Kundalei (M)	Apocynaceae
18.	*Coriaria nepalensis* Wall	Guipam (Tangkhul)	Coriariaceae
19.	*Crotalaria mucronata* Derv. Sen (H)	—	Papaveraceae
20.	*Dalbergia stipulacea* Roxb.	—	Papilionaceae
21.	*Datura stramonium* Linn.	Sagol hidak (M)	Solanaceae
22.	*Derris ferruginea* Benth	Kho (M)	Papilionaceae
23.	*Eclipta prostrata* Linn. Syn. *E. alba* (Linn) Hasak	Oochisumbal (M)	Asteraceae
24.	*Entada phaseoloides* Merrill	Kangkhil (M)	Mimosaceae
25.	*Erythroxylum coca* Linn.	—	Erythroxylaceae
26.	*Eupatorium odoratum* Linn	Kambilei (M)	Asteraceae

TABLE 1 (CONTD.)
POISONOUS PHANEROGAMIC PLANTS OF MANIPUR

Sl. No.	Latin name	Local name	Family
27.	*Euphorbia pulcherrima* Willd ex Klotzxch	Lalpata (M)	Euphorbiaceae
28.	*Gloriosa superba* Linn.	Karihari (M)	Liliaceae
29.	*Gynocardia odorata* R. Br.	—	Flacourtiaceae
30.	*Hedyotis scandens* R. Br.	—	Rubiaceae
31.	*Helminthostachys zeylanica*	Hook (M)	Ophioglossaceae
32.	*Holigarna longifolia* Buch. Ham. ex Roxb.	Kherai (M)	Anacardiaceae
33.	*Hydnocarpus kurzii* (King) Warb	Uhan (M)	Flacourtiaceae
34.	*Ipomoea carnea* Jaq.	—	Convolvulaceae
35.	*Jatropha gossypifolia* Linn.	Kege manbi (M)	Euphorbiaceae
36.	*Lyonia ovalifolia* (Wall) Drude	Tlangham (Mizo)	Ericaceae
37.	*Meconopsis aculeata* Royle	—	Papaveraceae
38.	*Mikania cordata* (Burm) B.L. Robinson	Urihingehabi (M)	Asteraceae
39.	*Millettia extensa* Benth ex. Baker	—	Fabaceae
40.	*M. pachycarpa*	Ngamuyai (M)	Fabaceae
41.	*Myrica esculenta* Buch. Ham.	Kaiphal (H & B)	Myricaceae
42.	*Nerium indicum* Linn.	Kabirei (M)	Apocynaceae
43.	*Nicandra physaloides* (Linn.) Gaertn	—	Solanaceae
44.	*Nicotiana tabacum* Linn.	Hidakmana (M)	Solanaceae
45.	*Ocimum gratissimum* Linn.	Ramtulasi (M)	Lamiaceae
46.	*Opuntia dillenii* Haw	Meipokpi (M)	Cactaceae
47.	*Pancratium zeylanicum* Linn.	—	Amaryllidaceae
48.	*Pandanus odoratissimus* Linn.	Ketukee (M)	Pandanaceae
49.	*Papaver dubium* Linn.	—	Papaveraceae
50.	*P. medicaule* Linn.	—	Papaveraceae
51.	*P. orientale* Linn.	—	Papaveraceae
52.	*Paspalum scrobiculatum* Linn.	Kodo (H)	Poaceae
53.	*Passiflora assamica* Chakravarty	Lamradhikanachom (M)	Passifloraceae
54.	*P. foetida* Linn.	Lamradhikanachom (M)	Passifloraceae
55.	*Pedilanthus teithymaloides* Linn. Poit	—	Euphorbiaceae
56.	*Pericampylus glaucus* (Lam.) Merr.	Barakanta (H & B)	Menispermaceae
57.	*Phyllanthus urinaria* Linn.	Chakpa heikru (M)	Euphorbiaceae
58.	*Phytolacca acinosa* Roxb.	Salad (M)	Phytolaccaceae
59.	*Pinus insularis* Syn. *P. khasiana* Linn.	Uchan (M)	Pinaceae
60.	*Pithecellobium clypearia* Benth Syn. *P. angulatum* Benth	Ardahpuri (Mizo)	Mimosaceae
61.	*Plumeria acuminata* Ait. Syn. *P. rubra* Linn.	Khagi leihao (M)	Apocynaceae
62.	*Polygonum chinense* Linn.	Angom yensil (M)	Polygonaceae
63.	*P. hydropiper* Linn.	Lilhar (M)	Polygonaceae
64.	*P. laphathifolium* Linn.	Chakhongmanba (M)	Polygonaceae
65.	*P. minus* Huds	Chakhong macha (M)	Polygonaceae
66.	*P. orientale* Linn.	Chakhong (M)	Polygonaceae
67.	*P. strigosum* R. Br.	—	Polygonaceae
68.	*Pongamia pinnata* Pierre	Karanj (B & H)	Fabaceae
69.	*Potentilla sundaica* Kuntze	—	Rosaceae
70.	*Prunus ceylanica* (Wight) Miq.	—	Rosaceae
71.	*Randia spinosa* Poin	Mainphal (H & B)	Rosaceae

TABLE 1 (CONTD.)
POISONOUS PHANEROGAMIC PLANTS OF MANIPUR

Sl. No.	Latin name	Local name	Family
72.	*Ranunculus scleratus* Linn.	Kakyel khujil (M)	Ranunculaceae
73.	*Rhododendron arboreum* Sm.	Kharamlaisok angangba (M)	Ericaceae
74.	*Sapindus trifoliatus* Linn.	Kekru (M)	Sapindaceae
75.	*Scirpus lacustris* Linn.	Kouna (M)	Cyperaceae
76.	*Senecio chrysanthemoides* DC.	—	Asteraceae
77.	*Setaria italica* (Linn.) Beauv.	Hoop (M)	Poaceae
78.	*Sida acuta* Burm f.	Uhal (M)	Poaceae
79.	*Solanum spirale* Roxb.	Lam khamen (M)	Solanaceae
80.	*Solanum torvum* Swartz	Shingkhangga (M)	Solanaceae
81.	*Sonchus branchiotus* DC. Syn. *S. arvensis* Linn.	Khomthokpi (M)	Asteraceae
82.	*Sphaeranthus indicus* Linn.	Mundi (H & B)	Asteraceae
83.	*Spilanthes acmella*	—	Asteraceae
84.	*S. oleracea* Murr.	—	Asteraceae
85.	*Stellaria media* Grimm.	Yerrum keirum (M)	Cariophyllaceae
86.	*Taxus baccata* Linn.	Common Yew (M)	Taxaceae
87.	*Tephrosia candida* DC.	Lasita (H)	Fabaceae
88.	*T. purpurea* Pers.	Dhamasia (H)	Fabaceae
89.	*Thevetia peruviana* (Pers.) Merr.	Utonglei (M)	Apocynaceae
90.	*Thuja occidentalis* Linn.	—	Cupressaceae
91.	*Trichosanthes wallichiana* (Ser) Wight Syn. *T. multiloba* Clarke	—	Cucurbitaceae
92.	*Wallichia densiflora* Mark.	—	Arecaceae
93.	*Xanthium stromarium* Linn.	Hameng sampaki (M)	Asteraceae
94.	*Xylosma longifolia* Clos	Nongleisang (M)	Flacourtiaceae
95.	*Zanthoxylum armatum* DC.	—	Rutaceae
96.	*Z. nitidum* (Roxb.) DC.	—	Rutaceae
97.	*Clerodendron siphonanthus*	Charoiutong (M)	Verbenaceae
98.	*Nerium indicum* Mill	Kabirei (M)	Apocynaceae
99.	*Hydrosome reverei*	Leen cheisu (M)	Araceae
100.	*Sauramatum guttatum*	Leen cheisu (M)	Araceae
101.	*Euphorbia tericulii*	Hu pambi (M)	Euphorbiaceae
102.	*E. antiquarum* Linn.	Tengnou (M)	Euphorbiaceae
103.	*Fleurya interrupta* Gaudich.	Santhak	Urticaceae
104.	*Adhatoda vasica* Nees	Nongmangkha (M)	Acanthaceae

In Manipur, some taxonomical work has been done, but toxic plants have not been studied so far. This list could help in the biochemical analysis of the medicinal or toxic plants of Manipur.

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50. STATUS OF PTERIDOPHYTIC DIVERSITY FROM DEWALTHAL HILLS OF PITHORAGARH (W. HIMALAYA)

From the taxonomy point of view, the Himalayan ferns have received considerable attention during the last century. Information on the fern vegetation is so far based on the classical pioneering work of Clarke (1880), Beddome (1892), Hope (1904) and Duthie (1906). Later, Khullar (1984), Punetha and Kaur (1987), and Punetha and Kholia (1989) explored the pteridophytic diversity and gave a comprehensive list of ferns and fern-allies of Pithoragarh district.

The Kumaon Himalaya is very rich in pteridophytic flora because of its varied topography, climate, soil and vegetation. Pithoragarh is one of the important districts of Kumaon Himalayas known as Shor valley, which is bounded by Nepal and Tibet. However, the ferns and fern-allies of Dewalthal hills seem to be neglected. Therefore, the present paper is an attempt to list ferns and fern-allies of the area.

Physiography and Vegetation: Dewalthal is situated at an altitude of 1,600 m and is about 22 km away from Pithoragarh. It is surrounded by mountains varying in elevation from 900-2,100 m. The main collection sites were Nakhnoli (1,400 m); Chammu (1,100 m); Pukhrora (1,300 m); Kakragar (1,200 m); Lori (2,100 m); Jingal (1,500 m); Dewalthal (1,600 m) and Surun (1,900 m).

The ground vegetation is covered with a more or less dense crop of grasses during rains. The mountain slopes are covered with forests of chir and oak. Near Rin, Chammu and Jingal forest patches of *Pinus longifolia* are interspersed with terraced fields. Between 1,500-1,800 m are mixed forests of *Quercus leucotrichophora*, *Rhododendron arboreum*, *Lyonia ovalifolia*, *Myrica esculenta* with bushes of *Phyrocantha cranulata*, *Rhus parviflora*, *Myrsine africana*, *Rubus ellipticus*, *Woodfordia floribunda* which give a prominent character to vegetation. The ground cover constitutes *Flemenzia fruticosa*, *Heteropogon contortus* and *Themeda anathera* among others. At higher elevations, the typical associates of *Quercus leucotrichophora* are *Rhododendron arboreum*, *Myrica esculenta*, *Quercus glauca*. The ground cover includes *Berberis asiatica*, *Myrsine africana* and *Deutzia staminea* among others.

ENUMERATION OF THE TAXA

Seventy species of ferns and fern-allies representing 38 genera and 22 families have been listed. The arrangement of families of ferns follows mainly Pichi-Sermolli (1977) with minor modification and that of fern-allies follows Ching (1978). All the species and genera under each family are arranged alphabetically with their latest nomenclature. The specimen number and name of locality are given for each taxon. The voucher specimens are deposited in the herbarium of the Department of Botany, Kumaon University Campus, Almora (ALM) Uttaranchal, India.

FAMILY: Selaginellaceae Milde

Selaginella bryopteris (Linn.) Bak.; Kushani; 1,600 m *(3113)*.

S. chrysocaulos (Hook. *et* Grev.) Spring; Pukhrora; 1,400 m *(3115)*.

S. delicatula (Desv. *ex* Poir) Alston; Lamtari; 1,400 m *(3117)*.

S. exigua Spring; Jingal; 1,350 m *(3120)*.

S. involvens (Sw.) Spring; Jingal; 1,350m *(3122)*.

S. sanguinalenta f. *indica* (Mild.) Alston;

Rinbichhul; 1,500 m *(2290).*

FAMILY: Equisetaceae L. C. Richard *ex* De Candolle

Equisetum diffusum D.Don; Mailkhet; 1,600 m *(3124).*

FAMILY: Ophioglossaceae (R. Br.) Agarhdh

Ophioglossum reticulatum Linn.; Kalsin Temple; 1,400 m *(3125).*

FAMILY: Loxogrammaceae Ching *ex* Pic.-Ser.

Loxogramme involuta (D. Don) Presl.; Koraltara; 2,000 m *(3203).*

FAMILY: Polypodiaceae Bercht. *et* Presl

Arthromeris wallichiana (Spr.) Ching; Lori; 1,900 m *(3128).*

Drynaria propinqua (Wall. *ex* Mett.) J. Sm.; Lori; 1,900 m *(3131).*

Goniophlebium amoenum (Wall. *ex* Mett.) J. Sm.; Dharamghar; 2,100 m *(3151).*

G. argutum (Wall. *ex* Mett.) J. Sm.; Lori; 1,900 m *(3155).*

Lepisorus amaurolepidus (Sledge) Bir & Trikha; Lori; 1,900 m *(3124).*

L. excavatus (Willd.) Ching; Lori; 1,900 m *(3137).*

L. mehrae Fras. Jenk.; Kuchha; 2,000 m *(3140).*

L. nudus (Hook.) Ching; Kakra; 1,800 m *(3157).*

Microsorium membranaceum (D.Don) Ching; Dharamghar; 2,100 m *(3145).*

Phymatopteris oxyloba (Wall. *ex* Kze) Pic.-Ser.; Dharamghar; 2,100 m *(3148).*

Pyrrosia flocculosa (D.Don) Ching; Kapri-Gao; 1,660 m *(2987).*

P. manni (Gies.) Ching; Gwata; 1,700 m *(2985).*

P. porosa (Presl) Hovenkamp; Kushani; 1,800 m *(2980).*

P. stigmosa (Sw.) Ching; Kushani; 1,800 m *(2975).*

FAMILY: Lygodiaceae C. Presl

Lygodium flexuosum (Linn.) Sw.; Lamtari; 1,400 m *(2973).*

L. japonicum (Thunb.) Sw.; Lamtari; 1,400 m *(2970).*

FAMILY: Sinopteridaceae Koidz

Cheilanthus bullosa Kunze; Chaupata; 1,600 m *(2965).*

C. dalhousiae Hook.; Bishonakhan; 1,300 m *(2970).*

C. rufa D.Don; Dewalthal; 1,800 m *(2961).*

FAMILY: Cryptogrammaceae Pic.-Ser.

Onychium cryptogrammoides Christ; Kushani; 1,700 m *(2974).*

FAMILY: Pteridaceae Ching

Pteris cretica Linn.; Pukhrora; 1,600 m *(2756).*

P. stenophylla Wall. *ex* Hook. *et* Grev.; Pukhrora; 1,600 m *(2759).*

P. subquinata Wall. *ex* Ag.; Pukhrora, 1,600 m *(2757).*

P. vittata Linn.; Bishonakhan; 1,500 m *(2756).*

P. wallichiana Ag.; Bishonakhan; 1,500 m *(2754).*

FAMILY: Adiantaceae (Pr.) Ching

Adiantum capillus-veneris Linn.; Surun; 1,900m *(2738).*

A. edgeworthii Hook.; Jingal; 1,400 m *(2755).*

A. incisum Forssk.; Manichhina; 1,600 m *(2763).*

A. lunulatum Burm. f.; Ghattgara; 1,600 m *(2118).*

FAMILY: Hemionitidaceae Pic.-Ser.

Gymnopteris vestita (Wall. *ex* Presl) Und.; Lori; 2,100 m *(3129).*

FAMILY: Hymenophyllaceae Link

Crepidomanes insigne (Bosch.) Fu; Nagrora; 2,000 m *(3129).*

FAMILY: Hypolepidaceae Pic.-Ser.

Hypolepis glandulifera Brownsey *et* Chinnock; Jingal, 1,400 m *(2290).*

Pteridium aqulinum (Linn.) Kuhn.; Kushani; 1,600 m *(3974).*

FAMILY: Lindsaeaceae Pic.-Ser.

Sphenomeris chinensis (Linn.) Maxon; Koraltara; 2,400m *(3142).*

FAMILY: Thelypteridaceae (C. Presl) Pic.-Ser.

Ampelopteris prolifera (Retz.) Copel.;

Devinagar; 1,200 m *(3209)*.

Christella arida (D.Don) Holtt.; Charma; 1,200 m *(3144)*.

C. dentata (Forssk.) Brownsey et Jermy; Bungachhina; 1,600 m *(2144)*.

Cyclogramma auriculata (J. Sm.) Ching; Chaupata; 1,500 m *(3127)*.

Glaphyropteridopsis erubescens (Wall. *ex* Hook.) Ching; Charma; 1,600 m *(3183)*.

Stegnogramma pozoi (Lag.) K. Iwats.; Jingal; 1,400 m *(2198)*.

FAMILY: Aspleniaceae Mett. *ex* Frank

Asplenium dalhousiae Hook.; Pukhrora; 1,600 m *(2768)*.

A. trichomanes Linn.; Dharamghar; 2,000 m *(2263)*.

A. varians Wall. *ex* Hook. *et* Grev.; Pukhrora; 1,600 m *(2768)*.

FAMILY: Athyriaceae Ching

Athyrium anisopterum Christ; Lori; 2,000 m *(3129)*.

A. pectinatum Presl; Kaprigao; 1,600 m *(3116)*.

A. schimperi Moug. *ex* Fee; Dewalthal; 1,700 m *(2959)*.

Deplazium esculentum (Retz.) Sw.; Rinbichhul; 1,500 m *(2949)*.

D. frondosum (Clarke) Christ; Dewalthal; 1,700 m *(2959)*.

Hypodematium crenatum (Forssk.) Kuhn.; Lawanthi; 1,600 m *(2186)*.

FAMILY: Aspidiaceae Mett. *ex* Frank

Dryopteris caroli-hopei Fras.-Jenk.; Bajat; 1,650 m *(2172)*.

D. chrysocoma (Christ) C. Chr.; Koraltora; 2,100 m *(3140)*.

D. cochleata (Ham. *ex* D.Don) C. Chr.; Kushani; 1,600 m *(2133)*.

D. juxtaposita Christ; Guroli; 1,800 m *(3132)*.

Polystichum discretum (D. Don) J. Sm.; Suron; 1,900 m *(2162)*.

P. mehrae Fras.-Jenk. *et* Khullar; Manichhina; 1,900 m *(2747)*.

P. squarrosum (D. Don) Fee; Bajat; 1,700 m *(2751)*.

Tectaria coadunata (J. Sm.) C. Chr.; Melapani; 1,500 m *(2177)*.

FAMILY: Nephrolepidaceae (Ching) Pic.-Ser.

Nephrolepis auriculata (Linn.) Trimen; Sualekh; 1,600m *(2283)*.

Oleandra wallichii (Hook.) Presl; Lori; 2,100m *(3136)*.

FAMILY: Davalliaceae Mett. *ex* Ching

Araiostegia pseudocystopteris (Kze.) Copel.; Lori; 2,100 m *(2137)*.

FAMILY: Blechnaceae (Presl) Copel.

Woodwardia unigemmata (Mak.) Nakai; Patarora; 1,500 m *(3102)*.

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   Aluri, Raju J.S. & C. Subha Reddi (1995): Ecology of the pollination in two cat-mint species. *J. Bombay nat. Hist. Soc. 92(1)*: 63-66.

   Prater, S.H. (1948): The Book of Indian Animals. Bombay Natural History Society, Mumbai. pp. 35-48.

6. Each paper should be accompanied by an abstract, normally not exceeding 200 words, and 6-8 key words. Key words should include the scientific names of important species discussed.

7. 25 reprints will be supplied free of cost to authors of main articles and new descriptions. Authors of miscellaneous notes, will be sent a free copy of the Journal.

8. The editors reserve the right, other things being equal, to publish a member's contribution earlier than a non-member's.

9. For the standardised common and scientific names of the birds of the Indian subcontinent refer to *Buceros* Vol. 6, No. 1 (2001).

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WE ARE GRATEFUL TO THE MINISTRY OF SCIENCE AND TECHNOLOGY,
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CITATION OF IC/EC NUMBERS FOR GENETIC MATERIALS

It is brought to our notice by the National Bureau of Plant Genetic Resources (NBPGR), Pusa Campus, New Delhi 110 012, India, that authors writing papers on particular plant materials (genetic materials) should indicate IC numbers for Indigenous Collections and EC numbers for Exotic Collections. Authors can directly procure these single accession numbers for each genetic material from NBPGR. In the present Intellectual Property Rights regime, it is in our national interest that all the germplasm material possess a single national accession number.

Authors are therefore requested to procure IC/EC numbers from NBPGR and state them on the manuscript, without which papers will not be accepted for publication.

Editors

Editorial

Think of common birds also

With a few exceptions, the Indian parliamentarians are not known for their concern for nature. It was a pleasant surprise when the Bombay Natural History Society (BNHS) received an urgent request from the officials of the Ministry of Environment and Forests, Government of India to help formulate a reply to a question on the status of the house sparrow (*Passer domesticus*). A concerned Member of Parliament (MP) wants to know what is happening to the ubiquitous house sparrow. The honourable MP had read somewhere that the house sparrow is decreasing in many countries such as the United Kingdom. He wanted to know "Is it true that in India also the sparrow population is decreasing, and if so, what steps does the Government propose to take to check the decline?"

We regularly hear about the destruction of nature and the alarming decrease in the number of rare species. This has made us almost unconcerned with the fate of the so-called common birds. We are taking it for granted that our common birds are still common. But is this the case? The sudden and dramatic decline in the number of *Gyps* species of vultures in South Asia, first reported by the BNHS, has proved that no species, no matter what its population is (or was), is safe. The vultures came into focus because they are large, conspicuous and were found in very high numbers in north India and their decrease was noticed even by the common man. But, what about the slow but steady decline of the Asian paradise flycatcher (*Terpsiphone paradisi*) in central India or the river tern (*Sterna aurantia*) in the Gangetic plains or the common iora (*Aegithina tiphia*) in Western Ghats. Has any one given attention to these so-called common and widespread species? Are they still found in the same numbers as they were 20 years ago? Is anyone collecting long term data? Unfortunately, the answer to all these questions is a resounding 'No'. We have no idea what is happening to our common birds. We have no long-term monitoring system. Our ignorance has created complacency bordering on apathy.

With massive urbanization, pollution, pesticides, change in agricultural practices, and increase in the number of crows, dogs and cats, the impact on common birds is great but undocumented. The house sparrow has disappeared from many metropolitan cities due to decrease in open areas and change in the architecture of houses (leaving less nesting sites). The innocent-looking domestic cat is not so harmless. Despite being well fed, sometimes overfed, by indulgent owners, its instinct teaches it to kill any small bird or mammals it can get hold of.

Our common garden birds, such as the ashy prinia (*Prinia socialis*), common tailor bird (*Orthotomus sutorius*) and purple sunbird (*Nectarinia asiatica*) are not safe if a cat is prowling around. Thanks to misguided animal-rights activists, there are too many cats and dogs lurking around in our cities, taking a heavy toll of urban wildlife.

The impact of pesticides, correctly termed as biocides, on birds is largely unknown in India. There is no Rachel Carson in India to tell us how many silent springs have passed since our Independence, how many birds have stopped singing. This is one field, which is open to universities and institutes for research.

The BNHS is conducting the Important Bird Areas (IBA) programme, and has established the Indian Bird Conservation Network (IBCN). IBAs are sites of international significance for bird conservation, and part of an integrated approach to conservation that embraces site, species and habitat protection.

The IBCN (www.ibcnetwork.org) is a network of Indian organizations and individuals who collaborate to promote the conservation of birds in India and the conservation of biological diversity as a whole through IBCN members. This Network will help in gathering data on common birds as well.

While collecting data for the IBA programme of the BNHS, funded by the Royal Society for the Protection of Birds, and sponsored by the BirdLife International, the IBA team has collated a huge amount of secondary data on birds. While we could collate data on rare species, there is practically no good scientific data on supposedly common birds. At the most, for many sites, we have presence/absence information, sometimes of a dubious nature. People still loosely use the terms 'common' 'uncommon', 'rare' without giving an explanation. There is no quantification; therefore, comparing data across years and across sites becomes difficult.

In the United Kingdom, with perhaps the largest number of bird watchers in the world, the British Trust for Ornithology (BTO) is collecting data on common birds for the last 60 years through hundreds of thousands of volunteers. Based on this data, the BTO can say what is happening to UK's birds. Good data leads to good decisions.

In India, monitoring of common birds is urgently required. The BNHS is planning to start such a scheme with the cooperation of IBCN members and interested ornithologists. Under the IBA project, the Society has already organized twelve highly successful bird census workshops, involving more than 350 people, all over the country. Many more are planned in the coming months. Through these workshops we want to familiarize our IBCN and BNHS members with basic bird census methodologies, so that quantifiable data can be collected on common birds. The scheme is being worked out, so if you have any suggestions, please write to us.

ASAD R. RAHMANI

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THE VERTICAL STRATIFICATION OF BIRDS IN MIXED SPECIES FLOCKS AT PARAMBIKULAM, SOUTH INDIA: A COMPARISON BETWEEN TWO HABITATS[1]

V.V. ROBIN[2,3] AND PRIYA DAVIDAR[2]

Key words: Mixed avian foraging flocks, mixed hunting party, Parambikulam, insectivorous flocks, vertical stratification, moist deciduous forest, teak plantation

The vertical stratification of mixed species flocks of birds was compared between moist deciduous forest and teak plantations at Parambikulam, South India. The foraging height, number of species, number of individuals, foraging substrate, and foraging manoeuvre were noted using five minute scan samples. The mean foraging heights of all species of birds were significantly different between the two habitats. The foraging height of drongos and minivets was higher in moist deciduous forest compared to teak plantations. There was also a shift by a few birds in the use of branches as a substrate in moist deciduous forest, to twigs in teak plantations, but no such trend was seen in the use of foraging manoeuvre. A long-term study is suggested for a deeper understanding of the behaviour of these flocks.

INTRODUCTION

Interspecific or mixed-species bird flocks are a widely occurring phenomenon that has attracted the attention of biologists for more than a century (Bates 1863). A mixed-species flock has been defined as "any group of two or more birds whose formation depends upon positive responses by individuals to members of their own or other species" (Morse 1970). Mixed-species flocks can be of many types (Morse 1977, Powell 1989) from small to large, composed of a few to many species, the species composition being consistent or variable, the number of individuals per species may be even or markedly uneven; the associations of the component individuals may be ephemeral, enduring only a few minutes or hours, or nearly permanent (Terborgh 1990).

Over a century of work on mixed-species flocks, various aspects have been studied. The two major hypotheses to explain the formation of mixed-species flocks (MSF) are: 1) feeding enhancement and 2) predator avoidance. Feeding advantages can be obtained in various ways. Some birds in mixed species flocks may capture insects that the members, as a whole, flush during their movement (Winterbottom 1943, Morse 1970). Birds in mixed-species flocks minimize duplication of effort by not searching for food in places already searched (Morse 1977). They are also able to exploit food resources otherwise not accessible, by copying the activities of others (Krebs 1973) and by social learning

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(Greig-Smith 1978). They avoid predators in various ways (Morse 1977). The detection of the predator is enhanced by the "more eyes hypothesis". Predators also may not be able to single out a prey due to "confusion effect".

The participants of mixed-species flocks have been classified as "nuclear" and "followers" or "attendants" (Greig-Smith 1978). When some species participate in flocks, various adjustments are made in order to reduce inter-specific competition and/or increase in foraging success. Many species increase their foraging success by copying nuclear or other species (Valburg 1992, Eguchi and Yamagishi 1993, Latta and Wunderle 1996).

Although a wealth of information is available on flocks from neotropical and temperate regions, very little is known of paleotropical flocks, especially from Asia (Jepson 1987). Studies of Asian flocks are restricted to Japan (Ogasawara 1965), Sarawak (Croxall 1976), Burma (Stanford 1947) and India (MacDonald and Henderson 1977, Vijayan 1989, Pramod *pers. comm.*). The flocks of the Western Ghats, India are very poorly understood, with information only from Vijayan (1984), Vijayan (1989) and Pramod (*pers. comm.*). While Vijayan (1984) demonstrated the shift in the use of vertical strata in three species of drongos in each others' presence, Pramod (*pers. comm.*) showed that the flocks in Silent Valley preferentially used the undergrowth and canopy, and characterised the species of 45 flocks into 'leading' and 'following' based on vocalisation.

It has also been found that the foraging height of some birds changes when they are present in a flock (Croxal 1976, MacDonald and Henderson 1977, Eguchi and Yamagishi 1993, Herrera 1979, Jones 1979, Latta and Wunderle 1996). However, there is hardly any information on the stratification of all birds in a flock, which may be a critical factor in determining various aspects of flocks, like inter-specific competition and the maximum number of birds and/or species that can be present in a flock. The habitat structure might also play an important role in the stratification of the flocks. In order to test these hypotheses, this study was undertaken at Parambikulam in Kerala, which has a large section of teak plantations and moist deciduous forests with no information available on the mixed species flocks inhabiting them.

The specific objectives of this study were:

1. To examine whether there exists any difference in the vertical stratification of birds in mixed-species flocks of two different habitats; teak plantation and moist deciduous forest.
2. To examine the probable causes of the difference in vertical stratification.

Study Area

Parambikulam Wildlife Sanctuary (76° 35'-76° 50' E and 10° 20'-10° 26' N), Western Ghats, Kerala is spread over 398 sq. km. It is a wide valley between the Nelliampathy hill ranges to the north and the Anamalais to the south.

The intensive study area consisted of valleys such as Tunacadavu, Tellickal and Parambikulam, with Parambikulam Valley being the largest in the Sanctuary.

The average annual rainfall is 1,723 mm, varying between 1,178 and 2,268 mm. The maximum temperature fluctuates between 24° and 33° C and the minimum between 20° and 25° C. February to April are the hottest months with low relative humidity.

Vegetation

The sanctuary exhibits a mosaic of vegetation, broadly classified based on Champion and Seth (1968) into Southern Tropical Wet Evergreen, Southern Tropical Semi-evergreen, Southern Tropical Moist Deciduous and Southern Tropical Dry Deciduous (Vairavel 1998).

Moist Deciduous Forests

Moist Deciduous Forests occur between 400-1,000 m elevation covering almost 60 sq. km in the Sanctuary. The top canopy remains leafless between March and May. Most teak plantations were raised after clear felling these forests.

Teak plantations

Teak plantations cover an area of *c.*100 sq. km. The stands are of different ages, planted between 1916 and 1982 (Vairavel 1998). The undergrowth in many plantations has been cleared for various purposes.

Methodology

Mixed-species flock

A reconnaissance of the area was done to identify different trek paths and trails to be used. A mixed-species foraging flock was identified after verifying the sighting for two minutes. Five-minute scan samples were made on each flock; a maximum of three such observations were taken with two minute intervals (Altmann 1974) from the time of flock identification.

Different trails and paths were followed every day in order to obtain sufficient replicates. However, parts of a few trails might have been walked more than once. The foraging height of each individual bird, substrate used (trunk, branch, twig, foliage and ground), foraging manoeuvre exhibited (broadly classified under fly-catching, gleaning, probing and flycatcher-gleaning), and number of species and number of conspecifics were recorded. Occurrences of aggressive behaviour and individuals closely following other individuals were noted.

Vegetation

Ten 10 m x 10 m plots were laid in both teak plantations and moist deciduous forests. Plots were laid alternately at 15 m to the right and left of the trail, at 100m intervals. In every plot, the number of trees present (>10 cm gbh), the maximum height and gbh of every tree were recorded. For each tree, the height of the first twig and the first branch present were noted.

Presence or absence of foliage on a tree was noted every 2 m, from 2 m to the maximum height of the tree. In order to quantify the shrub or undergrowth, every 10 m x 10 m quadrate was divided into 25 cells measuring 2 m x 2 m. The maximum height of the shrub/undergrowth in each such cell was noted.

Analysis

All analysis was done using SPSS version 7.5.

Results and Discussion

One hundred flocks were spotted in the teak plantation and 188 observations (of five minute scans) were made on them. For the same number of flocks spotted in the Moist Deciduous Forest, 178 observations were made. Since the number of observations for each flock varied from one to three, each observation was taken as a unit for analysis. A total number of 61 species of birds and two species of primates were found in Moist Deciduous Forest and 57 species of birds and one species of giant squirrel (*Ratufa indica*) was found in teak plantations (Appendix 1). It has to be noted that different species of warblers and flower-peckers were not recorded to the species level due to difficulty in identification. Spending more time to identify these species could have resulted in missing other species. Common golden-backed woodpecker *Dinopium javanense* and lesser golden-backed woodpecker *Dinopium benghalense* were together considered as "golden-backed woodpecker" due to unclear identifications in the initial stages of the fieldwork. However, since they work as a guild (gleaners and probers), the problem in sampling may not be very significant in a mixed species foraging flock.

Of all the birds in both habitats (Appendix 1), only 10 species (Table 1) were common (>11%) to both the habitats. The foraging heights of all birds in both the habitats were compared using t-test and showed that the birds forage significantly higher in Moist Deciduous Forests (P=0.000) (Table 2). The data on 10 common species was used for analysis of vertical stratification. There seemed to be a definite trend in the vertical stratification of birds. Forty-five different combinations of the ten common species were analysed for variability in foraging height using paired sample t-test for the various combinations (Table 3). Most combinations of species (97%) showed that mutually exclusive foraging heights are used by most species except the following: white-bellied drongo *Dicrurus caerulescens* occupied similar heights as the bronzed drongo *Dicrurus aeneus* (P=0.346) and velvet-fronted nuthatch *Sitta frontalis* (P=0.803); large woodshrike *Tephrodornis gularis* had foraging heights similar to scarlet minivet *Pericrocotus flammeus* (P=0.406) and white-bellied drongo (P=0.611); great tit *Parus major* shared its foraging height with the bronzed drongo (P=0.813) (Table 3). The greater racket-tailed drongo *Dicrurus paradiseus* was found in the lower parts of both the habitats. Bronzed drongo preferred a higher stratum than the greater racket-tailed drongo. Such vertical stratification has also been observed by Vijayan (1984) at Thekkady. The reason for the same was hypothesised to be the avoidance of inter-specific competition. The minivets were found from

Table 1: Ten common species in the flocks of Moist Deciduous Forest and Teak Plantation

Species	Abbreviation
Great racket-tailed drongo	RTD
Bronzed drongo	BDR
White-bellied drongo	WBD
Scarlet minivet	SCM
Small minivet	SMM
Large woodshrike	LWS
Great tit	GTT
Jungle babbler	JBB
Golden-backed woodpeckers	GBW
Velvet-fronted nuthatch	VFN

Table 2: Comparison of foraging heights of all birds in Teak Plantation and Moist Deciduous Forest

Habitat	N	Mean	S.D	S.E	P
Teak	1910	7.41	5.13	0.12	0.000
MDF	1528	8.86	5.62	0.14	

Table 3: Paired t-test p values for difference in height of ten common species of birds in Teak Plantation and Moist Deciduous Forest

	BDR	WBD	SCM	SMM	LWS	VFN	JBB	GTT	GBW
RTD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0094
BDR		**0.3461**	0.0000	0.0000	0.0011	0.0000	0.0000	**0.8133**	0.1001
WBD			0.0617	0.0000	**0.6115**	**0.8032**	0.0000	0.0036	0.0003
SCM				0.0140	**0.4069**	0.0009	0.0000	0.0002	0.0000
SMM					0.0000	0.0000	0.0000	0.0033	0.0000
LWS						0.0253	0.0000	0.0429	0.0000
VFN							0.0000	**0.1656**	0.0000
JBB								0.0000	0.0000
GTT									0.0292

Values in bold are not significant

middle to higher zone, while the jungle babbler *Turdoides striatus* seemed to prefer the undergrowth and ground. The other gleaners and probers (golden-backed woodpeckers, great tit, velvet-fronted nuthatch and large wood shrike) were found in varying heights in the middle strata.

Significant differences in foraging height were found in five species (Table 4) when the foraging heights of each of the 10 common species were compared between the two habitats. Various factors were considered for the difference in foraging height.

Height of trees

If the height of the trees in one habitat is greater than the height of trees in the other, it could naturally cause an increase in the foraging height of the birds. It must be noted that the teak plantations in Parambikulam are fairly old: the trees have undergone silvicultural thinning and the surviving trees are considerably tall. The analysis of tree heights in the two habitats revealed that teak plantation trees were taller than the moist deciduous forest trees (P=0.017) (Table 5). Thus, if the birds' choice of foraging

Table 4: Comparison of mean heights between two habitats of ten commom species (t-test)

Species	Habitat	Mean height (m)	N	Std. Deviation	Std. Error	t-value	*p*
RTD	MDF	6.51	108	3.86	0.37	2.1548	0.0334
	Teak	5.42	108	3.36	0.32		
BDR	MDF	9.44	217	4.72	0.32	3.7180	0.0002
	Teak	7.85	217	3.67	0.25		
WBD	MDF	10.17	29	5.68	1.05	3.0203	0.0053
	Teak	5.93	29	4.05	0.75		
SCM	MDF	11.96	221	5.43	0.37	2.2537	0.0252
	Teak	10.82	221	5.14	0.35		
SMM	MDF	12.15	62	4.41	0.56	-0.1697	0.8658
	Teak	12.32	62	5.31	0.67		
LWS	MDF	9.87	46	4.94	0.73	0.1990	0.8430
	Teak	9.67	46	4.44	0.65		
VFN	MDF	9.38	64	4.24	0.53	2.0770	0.0419
	Teak	8.00	64	3.18	0.40		
JBB	MDF	2.07	119	2.10	0.19	2.2630	0.0254
	Teak	1.51	119	2.11	0.19		
GTT	MDF	7.64	22	5.18	1.10	-1.5655	0.1324
	Teak	9.64	22	4.36	0.93		
GBW	MDF	7.26	76	4.32	0.50	1.1147	0.2685
	Teak	6.41	76	4.00	0.46		

Table 5: Comparison of habitat parameters between Moist Deciduous Forest and Teak Plantation

Habitat	Parameter	Mean height (m)	N	S.D	S.E	t-value	*p*
MDF	height	19.57	10	2.89	0.91	-2.9290	0.017*
Teak	height	24.9	10	3.6	1.14		
MDF	branch	7.28	10	1.86	0.59	-3.2950	0.009*
Teak	branch	10.69	10	2.55	0.80		
MDF	twig	6.47	6	2.9	1.21	-0.8600	0.9350
Teak	twig	6.69	6	3.3	1.38		
MDF	undergrowth	1.806	10	0.85	0.27	6.4496	0.0001*
Teak	undergrowth	0.285	10	0.19	0.06		

* significant

height was due to an increase in the height of trees in the two different habitats, a reverse trend (lower foraging height in Moist Deciduous Forest) should have been seen. However, the foraging height of all birds was greater in the Moist Deciduous Forests. Hence, tree height does not appear to contribute directly to the foraging height of birds. However, the sample size for the habitat parameters data is small (N=10 in each habitat) and the result may be biased.

Foraging manoeuvre

The drongo used sallying as its foraging manoeuvre on most occasions (96%, Table 6) (X^2, p=0.000). It has been said that foraging manoeuvre of a species could change depending on the kind of prey that is pursued. This difference in prey selection could also cause an increase in foraging height of the birds if there is a variation in prey availability. The foraging manoeuvre, however, did not seem to vary and most birds followed the same method of prey capture in both the habitats. Pinkowski (1979) in his study of *Sialia* sp. suggested that sallying might be a more expensive foraging manoeuvre than gleaning or flycatcher-gleaning. However, flycatcher-gleaning and gleaning involve active searching for prey, and when the drongos (the predominantly sallying species in this study) form part of mixed species foraging flocks, they wait for the prey to be flushed by the gleaners. With abundant aerial prey, sallying might be bio-energetically more viable. Pinkowski (1979), in his model, proposed that if an aerial prey is visible, it would be the first choice for the fly-

Table 6: Percentage use of foraging manoeuvre by ten common species in the two habitats

Species	Habitat	Gleaning	Sallying	Fly-catcher gleaning	Probing
RTD	teak	2.78	94.44	2.78	
	MDF	2.78	96.30		0.93
BDR	teak	1.27	98.10	0.63	
	MDF		100.00		
WBD	teak	1.47	95.59	2.94	
	MDF	6.90	93.10		
SCM	teak	93.25	0.42	5.91	0.42
	MDF	97.29	1.36	1.36	
SMM	teak	96.77		3.23	
	MDF	87.10	4.84	8.06	
LWS	teak	95.65		4.35	
	MDF	93.02	4.65	2.33	
VFN	teak			0.77	99.23
	MDF	1.56	1.56		96.88
JBB	teak	50.00	0.71		49.29
	MDF	61.34			38.66
GTT	teak	100.00			
	MDF	100.00			
GBW	teak				100.00
	MDF				100.00

catching species. No significant difference in foraging behaviour was seen in different species between the two habitats. This could be because there is no functional difference in the flocks of both the habitats; i.e. gleaners flush insects and sallying species follow, irrespective of the habitat that the flock is in. Drongos at Thekkady preferred sallying when in the presence of other birds, but flycatcher-gleaning when feeding solitarily (Vijayan 1984). This further corroborates the choice of sallying as a preferred foraging manoeuvre for the drongos in mixed species flocks. Studies by Latta and Wunderle (1996) and Jones (1977) also show that shifts in the foraging manoeuvre of birds occur when feeding in flocks compared to feeding solitarily, possibly due to inter-specific competition. However, there is no data on this aspect in this study.

Substrate characters and use

The availability of suitable substrate was thought to be a limiting factor in vertical stratification of a species. A species' preference for a particular substrate and its availability at a higher stratum in moist deciduous forest could cause an increase in the foraging height. It was found that many species showed a strong preference for a particular substrate. For the sallying drongos whose prey capture location is air, the substrate is merely a perching site, whereas for gleaners it is also the location of prey capture. The drongos preferred twigs (X^2, P=0.000) compared to other substrates (Table 7). However, the height of primary twig in the two habitats did not seem to show any significant difference (P=0.93) (Table 5) and thus, the change in foraging height of the drongos might not be due to the change in height of its preferred substrate, twigs. In Teak Plantations, there was an increased use of branches by the drongos as a substrate, compared to that in the Moist Deciduous Forest, but the percentage of usage

Table 7: Percentage use of substrate by ten common species in the two habitats

Species	Habitat	Foliage	Twig	Branch	Trunk	Ground/ undergrowth
RTD	teak	0.69	84.03	14.58	0.00	0.69
	MDF	0.00	94.44	2.78	0.00	2.78
BDR	teak	0.63	86.03	13.33	0.00	0.00
	MDF	0.92	96.77	2.30	0.00	0.00
WBD	teak	0.00	69.12	30.88	0.00	0.00
	MDF	0.00	93.10	6.90	0.00	0.00
SCM	teak	87.34	7.17	5.06	0.42	0.00
	MDF	92.31	5.43	0.90	0.00	1.36
SMM	teak	87.10	8.06	4.84	0.00	0.00
	MDF	95.16	3.23	1.61	0.00	0.00
LWS	teak	4.35	76.09	19.57	0.00	0.00
	MDF	1.16	65.12	32.56	0.00	1.16
VFN	teak	0.00	30.77	36.92	32.31	0.00
	MDF	0.00	28.13	32.81	39.06	0.00
JBB	teak	1.79	18.57	20.36	3.57	55.71
	MDF	0.84	20.17	22.69	10.92	45.38
GTT	teak	27.27	63.64	9.09	0.00	0.00
	MDF	57.14	34.29	2.86	0.00	5.71
GBW	teak	0.00	2.55	26.75	70.06	0.64
	MDF	0.00	3.95	31.58	64.47	0.00

(14.58%) (Table 7) was not high. However, the height of primary branching is greater in teak plantations (P=0.009) (Table 5) and this shift in substrate does not seem to have influenced the foraging height of the drongos. This indicates that the drongos shifted their foraging perch to higher twigs in the Moist Deciduous Forest. One of the reasons for such a shift could be the greater abundance of twigs at a higher stratum in moist deciduous forest than in Teak Plantation, but habitat data are inadequate to draw a conclusion in this regard. The drongos were also found to be following the gleaning species most of the time (e.g. bronzed drongo followed scarlet minivet and greater racket-tailed drongo followed golden-backed woodpeckers) (Robin 2000). There appeared to be an increase in the foraging height of the scarlet minivet (P=0.02) and this could have caused an increase in the foraging height of the bronzed drongo (P=0.03). The increase in foraging height of the scarlet minivet could be due to the availability of suitable substrate at a higher stratum in the Moist Deciduous Forest. However, there seemed to be no significant change in the foraging height of the small minivet *Pericrocotus cinnamomeus* between the two habitats (P=0.86) and a difference, if any, could be due to inter-specific competition as they are conspecifics. The foraging height of only the great tit showed a decrease in the Moist Deciduous Forest (P=0.13) while the large woodshrike showed no significant change (P=0.86) (Table 4).

There seemed to be no significant change in substrate use of minivets, nuthatch, great tit and golden-backed woodpeckers (Table 7). The jungle babbler used undergrowth and ground more than any other substrate in both the habitats (X^2, P=0.000). However, there seemed to be a higher percentage of ground/undergrowth utilisation in Teak Plantation and the utilisation of trunk in Teak Plantation was lower than in Moist Deciduous Forest (Table 7). The high percentage of use of ground/undergrowth could be because Teak Plantation had less undergrowth cover than Moist Deciduous Forest (X^2, P=0.000). Hence, the visibility of the babblers could have been higher in Teak Plantations. The babblers might also have preferred to feed on open ground than in denser undergrowth, as visibility of insects might be higher. Since "undergrowth/ground" was considered as a single substrate, quantitative information on whether ground is preferred to undergrowth is not available. Higher utilisation of trunk in Moist Deciduous Forest could be due to difference in prey availability. However, more data are required to confirm this. There seemed to be an increase in the height of undergrowth in Moist Deciduous Forest (P=0.0001) (Table 5) and the preference of jungle babbler towards undergrowth/ground could have resulted in an increase in its foraging height (P=0.025) (Table 4) in Moist Deciduous Forest.

The velvet-fronted nuthatch used branches, trunk and twigs almost evenly but the use of branches seemed to be higher in Teak Plantations (Table 7). Since the primary branching was found lower in Teak Plantations (Table 5), the increase in height in Moist Deciduous Forest could be due to its choice of higher parts of twigs, trunk and branches other than primary branches.

The shift in the substrate could also be due to inter-specific competition as found in Alatalo's (1981) study where great tits and gold crests shifted their foraging sites depending on the presence or absence of each other.

Other possible reasons

The availability of food in a higher area in Moist Deciduous Forest could be one of the possible reasons for an increase in the foraging height of most birds in that habitat. However, this aspect was not studied. Inter-specific competition and niche separation could be another reason for an increase in foraging height. However, most of the species occurring in Moist

Deciduous Forest were found in Teak Plantations as well, and a shift in foraging height in all birds due to this factor is unlikely. The presence of most birds in a higher stratum could also be due to the phenological phase of the trees in the habitat during the study period. The Moist Deciduous Forests were sampled in February-March when leaf fall had commenced, whereas Teak Plantation was sampled in December-January, before the leaf-fall. Pinowski (1979) states that dead and leafless branches might offer an unobstructed view for searching prey. He found eastern bluebirds using higher perches in summer than in spring. The birds could thus have shifted to a higher stratum in the season when leaf-fall occurred. However, sampling of the mixed species flocks in the two habitats in the same season could have given a more accurate idea of the same.

The study reveals that not only is there a clear vertical stratification in the birds in mixed species flocks, but also a difference in the usage of height between the two habitats. However, the factors influencing the shift in foraging height could be any of the above or could be a combination of various factors. Different species may have different factors affecting their vertical stratification. Carefully designed long-term studies should be carried out considering various seasonal changes, to determine these causes. Quantification of prey base, though difficult in the field, has to be done in order to understand prey availability and response of different species to it. Colour banding individual birds might facilitate identification of individuals and would result in greater understanding of the dynamics of the flocks.

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Appendix 1: Percentage occurrence of birds and *mammals in flocks of two habitats

Species	Scientific name	% Occurrence Teak	% Occurrence MDF
Bronzed drongo	*Dicrurus aeneus*	78.19	66.85
Greater racket-tailed drongo	*Dicrurus paradiseus*	61.70	51.69
Scarlet minivet	*Pericrocotus flammeus*	48.94	51.12
Golden-backed woodpeckers	*Dinopium* sp.	45.21	30.90
Large woodshrike	*Tephrodornis gularis*	11.17	24.72
Velvet-fronted nuthatch	*Sitta frontalis*	40.96	24.16
Grey-headed starling	*Sturnus malabaricus*	7.98	19.66
White-cheeked barbet	*Megalaima viridis*	1.60	15.73
Small minivet	*Pericrocotus cinnamomeus*	15.96	15.73
Great tit	*Parus major*	11.17	15.17
White-bellied drongo	*Dicrurus caerulescens*	34.57	14.61
Jungle babbler	*Turdoides striatus*	26.60	14.61
Indian treepie	*Dendrocitta vagabunda*	10.11	12.92
Red-whiskered bulbul	*Pycnonotus jocosus*	2.66	11.24
Ashy drongo	*Dicrurus leucophaeus*	15.43	10.67
Red-vented bulbul	*Pycnonotus cafer*	7.45	10.67
Gold-fronted chloropsis	*Chloropsis aurifrons*	6.91	10.67
Eurasian golden oriole	*Oriolus oriolus*	3.19	10.67
Oriental magpie-robin	*Copsychus saularis*	1.06	8.99
Brown-capped pygmy woodpecker	*Dendrocopos nanus*	13.30	8.99

APPENDIX 1 (*contd.*): Percentage occurrence of birds and *mammals in flocks of two habitats

Species	Scientific name	% Occurrence Teak	% Occurrence MDF
Plum-headed parakeet	*Psittacula cyanocephala*	4.79	8.99
Black-headed oriole	*Oriolus xanthornus*	6.91	8.43
White-bellied treepie	*Dendrocitta leucogastra*	6.91	7.30
Warblers	(various genera)	5.85	7.30
Iora	*Aegithina tiphia*	3.72	6.74
Brown-eared bulbul	*Iole indica*	1.60	6.18
Small yellow-naped woodpecker	*Picus chlorolophus*	9.57	6.18
Asian paradise-flycatcher	*Terpsiphone paradisii*	9.04	5.62
Common myna	*Acridotheres tristis*	11.70	5.06
Asian brown flycatcher	*Muscicapa dauurica*	2.66	3.37
Tickell's blue-flycatcher	*Cyornis tickelliae*	0.00	3.37
Yellow-fronted pied woodpecker	*Dendroscopus mahrattensis*	1.60	3.37
Large green-billed malkoha	*Phaenicopterus tristis*	1.60	3.37
Three striped palm squirrel	***Funambulus palmarum***	**3.19**	**3.37**
Flowerpeckers	*Dicaeum* sp.	3.19	2.81
Common woodshrike	*Tephrodornis pondicerianus*	2.13	2.81
Spotted dove	*Streptopelia chinensis*	6.38	2.81
Jungle owlet	*Glaucidium radiatum*	0.53	2.25
Large cuckoo shrike	*Coracina macei*	1.60	1.69
Heart-spotted woodpecker	*Hemicircus canente*	1.06	1.69
Common hoopoe	*Upupa epops*	1.06	1.69
Pied flycatcher-shrike	*Hemipus picatus*	1.06	1.69
Ruby-throated bulbul	*Pycnonotus melanicterus gularis*	0.00	1.69
Drongo cuckoo	*Surniculus lugubrius*	0.00	1.12
Bonnet macaque	***Macaca radiata***	**0.00**	**1.12**
Blue-throated flycatcher	*Cyornis rubeculoides*	0.00	1.12
Chestnut-headed bee-eater	*Merops leschenaulti*	0.00	1.12
Asian fairy-bluebird	*Irena puella*	4.79	0.56
Indian rufous babbler	*Turdoides subrufus*	0.00	0.56
Black-naped monarch-flycatcher	*Hypothymis azurea*	0.53	0.56
Little spiderhunter	*Arachnothera longirostra*	1.06	0.56
Black-naped oriole	*Oriolus chinensis*	1.06	0.56
White-breasted kingfisher	*Halcyon smyrnensis*	2.13	0.56
Greater coucal	*Centropus sinensis*	1.60	0.56
Black bulbul	*Hypsipetus leucocephalus*	0.00	0.56
Nilgiri langur	***Presbytis johni***	**0.00**	**0.56**
Black-headed babbler	*Rhopocichla atriceps*	0.00	0.56
White-rumped munia	*Lonchura striata*	0.00	0.56
Malabar whistling-thrush	*Myiophonus horsfieldii*	0.00	0.56
Purple sunbird	*Nectarinia asiatica*	2.13	0.00
Brown shrike	*Lanius cristatus*	2.13	0.00
Rufous woodpecker	*Celeus brachyurus*	0.53	0.00
Grey junglefowl	*Gallus sonneratii*	3.19	0.00
Common tailorbird	*Orthotomus sutorius*	1.06	0.00
Asian koel	*Eudynamys scolopacea*	0.53	0.00
Orange headed thrush	*Zoothera citrina*	1.06	0.00
Small sunbird	*Nectarinia minima*	1.06	0.00
Jungle crow	*Corvus macrorhynchos*	1.06	0.00
Malabar giant squirrel	***Ratufa indica***	**0.53**	**0.00**

* Mammals in bold letters

ACTIVITY SCHEDULE AND HABITAT USE OF THE SLENDER LORIS *LORIS TARDIGRADUS LYDEKKERIANUS*[1]

Sindhu Radhakrishna[2] and Mewa Singh[3]

Key words: slender loris, activity budget, moon phase, diet, tree species, intersexual differences

The behavioural ecology of the nocturnal prosimian *Loris tardigradus lydekkerianus* in its natural habitat was studied for a period of 21 months. Twenty-eight identified study individuals belonging to different age-sex categories were observed for 2364 hours. Data collected on the general activity schedule of the species showed changes in response to the phases of the moon, and seasonal variations. Insects made up the greater portion of the diet of the slender loris, with fruits and gum being included to a small extent. Intersexual differences were seen in the height of trees used by the animals and heights at which the animals preferred to stay in the trees.

Introduction

The slender loris (*Loris tardigradus*) is one of the two nocturnal prosimians found in India. The species has been declared Vulnerable (IUCN 2000), yet little has been done to conserve this primate in the wild. The major stumbling block is the lack of complete information on its behaviour in its natural habitat. Though it was used extensively in anatomical studies (Rao 1927, Swayamprabha 1983, Manjula 1984, Sarma and Kadam 1984) in the past and its reproduction studied in detail (Ramaswami and Kumar 1962, 1965; Ramakrishna and Prasad 1962, 1967; Kadam and Swayamprabha 1980; Izard and Rasmussen 1985), very little is known about its behaviour in the wild.

In September 1996, a population survey of the slender loris conducted by Singh *et al.* (1999) discovered high densities of the subspecies *lydekkerianus* in the scrub jungles of the Eastern Ghats, South India. Singh *et al.* (1999) recommended that these fragmented populations needed to be conserved, and emphasized the need for a long-term behavioural study to provide more data for management strategies. A study was therefore undertaken on the social behaviour of the slender loris *L.t. lydekkerianus* in its natural habitat. The data collected on its activity budget and habitat use is presented here.

Study Area

The Beerangi Karadu hill range (10° 29' N, 78° 10' E, altitude: 400 m above msl) of Ayyalur Forest range was chosen, as an earlier study (Singh *et al.* 1999) reported a high density of slender loris in this area. The climate is hot and humid (max. temp.: 34.19°C, min. temp.: 23.34°C, relative humidity: 80.74%), and the annual rainfall (mean: 869.6 mm) is received mostly from the northeast monsoon during September-October. The area spans about 16 ha of open dry scrub jungle. A road runs through, bisecting it into two different habitats. On one side lies the Reserved Forest, secondary degraded habitat rising uphill, and vegetation mainly *Acacia*, *Euphorbia*, *Azadirachta*, *Albizia* and *Cassia*. Though tree felling is illegal, it went on surreptitiously all the time. On the other side of the road lies a *Tamarindus* and *Eucalyptus* orchard, and fields bordered by *Cocos nucifera*.

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Except for the odd row of trees that provide contiguity, being planted closely, there is little canopy in this part of the study area. *Prosopis*, *Commiphora* and *Azadirachta* overgrown with lianas, provide a natural fence along the road; this was an important area of ranging for the loris.

Methods

The study began in October 1997 and concluded in June 1999. Observations of the first month were used to prepare an ethogram and decide upon a suitable sampling method. Observations were conducted on foot every night from dusk to dawn (1800 to 0600 hrs). An animal was first spotted by its unique orange-red tapetal reflection to light, from more than 100 m away. It was then approached for identification and followed the rest of the night. Petzl headlamps covered with red cellophane were used, as red light did not disturb the animals and ensured better observation (Charles-Dominique 1977, Charles-Dominique and Bearder 1979).

Instantaneous point and *ad libitum* sampling techniques (Altmann 1974, Anon. 1981) were used. A five-minute instantaneous sampling technique was employed to record the behavioural categories of the animal at night. A total of 22,834 instantaneous scans were collected: 21,019 scans on 28 identified individuals and 1,815 scans on unidentified loris. Study animals were identified by distinctive physical markings on their bodies and locomotory idiosyncrasies. Each scan recorded information on the identity of the individual, behaviour the animal was engaged in, time, moon phase, tree species, tree height, height of focal location of animal on tree, identity of nearest neighbour, inter-individual distance and vocalization. *Ad libitum* sampling was used to describe events (copulation, agonistic interactions) that occurred too quickly for regular sampling methods, or the sequences in activities like social behaviour, feeding, etc. which were not adequately represented in the focals.

Six main behavioural categories were recognized: locomotion, exploration, feeding, inactivity, social, and self-directed. Locomotion refers to activity that occurred with no ostensible purpose of exploration. Its sub-categories were locomote, shift from one tree to another, shift from tree to ground, hesitation to complete shift to tree or ground, movement of just a pace or two. Exploration was defined as activity to investigate the environment. The sub-categories were forage, urine-mark and sniff. Feeding was recorded when a loris was observed ingesting. Food materials belonged to one of the three categories: insects (arthropods and other invertebrates), plant material (all plant parts) and gum (plant exudates). Inactivity was recorded when the animal was totally passive: sit, freeze, sleep, and pause. Social behaviour included all associative and agonistic encounters. Sub-categories of social behaviour were sleep together with other individual(s), locomote/ sit/ autogroom near another individual, allogroom, play, aggressive vocalization, physical fight, sniff conspecific, approach, carry infant, and carried by mother. Self-directed activities were those performed by the animal on itself: scratch, urine-wash, autogroom.

The hours of loris activity were divided into thirteen categories, beginning from 1730 to 0530 hrs, with each category representing an hour. The phases of the moon were divided into two main categories according to the amount of light available: the light phase, from half-moon to full moon and then to half-moon, and the dark phase, from half-moon to new moon and then to half-moon. Rainfall conditions were recorded as the dry season from January to June and the wet season from July to December. Height of the tree and the height of the animal on the tree were classified into seven categories: undergrowth/ base of tree, < 1 m, 1-3 m, 3-5 m, 5-8 m, 8-10 m and 10-15 m. None of the trees in the study area were taller than 15 m.

Data Analysis

Data analysis was carried out using the statistical package SPSS for Windows, Version 9.0. Percent values of scans were calculated for the habitat and behavioural variables. z tests (Gibbons 1971) were used in binomial situations to test for significant differences in the proportion of scans for any behavioural category. Chi Square goodness-of-fit tests were used to check if a particular behaviour or habitat variable was more significant than another. Intersexual differences were subjected to two-tailed analysis of variance test. Pearson correlation was used to test the degree of correlation between climatic factors and activity variables of the species. A step-wise multiple regression analysis was also run to see if climatic variables affected the activity schedule of the animal.

Results

Activity Budgets

Calculation of percent scans showed that 47.27% of the general activity schedule of the species was exploration and 26.90% was inactivity. The number of scans for the different behavioural categories significantly differed from each other ($\chi^2 = 20877.39$; df = 5; $P < 0.01$). The general activity schedule of the species was analysed for changes with respect to the hours of the night, moon phases and climatic variables (Table 1). The proportion of scans was significantly higher before midnight (1730 to 2330 hrs) for the behavioural categories: locomotion and self-directed; the proportion of scans for social behaviour was significantly higher after midnight (2330 to 0530 hrs). The proportion of scans was significantly higher in the dark phase of the moon for the exploration category and in the light phase for the inactive category. All the behavioural categories showed significant changes for the dry and wet seasons: locomotion, feeding, inactivity and self-directed behaviour increased in the dry season while exploration and social behaviour increased in the wet season.

A Pearson correlation test of the climatic variables and the activity budget presented

Table 1: Activity budget of the slender loris

	Locomotion scans	Exploration scans	Feeding scans	Inactivity scans	Social scans	Self scans
General Activity Schedule	2998 (13.17%)	10757 (47.27%)	565 (2.48%)	6122 (26.90%)	1557 (6.84%)	758 (3.33%)
Night hours						
1730-2330 hrs	1414 (13.68%)	4873 (47.16%)	272 (2.63%)	2764 (26.75%)	621 (6.01%)	390 (3.77%)
2330-0530 hrs	1584 (12.75%)	5884 (47.37%)	293 (2.36%)	3357 (27.02%)	936 (7.54%)	368 (2.96%)
z values	2.07*	0.32	1.32	0.47	4.54**	3.40**
Moon Phases						
Light Phase	1534 (13.18%)	5216 (44.80%)	279 (2.40%)	3409 (29.28%)	801 (6.88%)	403 (3.46%)
Dark Phase	1464 (13.17%)	5541 (49.86%)	286 (2.57%)	2713 (24.41%)	756 (6.80%)	355 (3.19%)
z values	0.001	7.63**	0.86	8.29**	0.23	1.13
Seasonal						
Dry Season	1352 (16.77%)	2208 (27.39%)	240 (2.98%)	3512 (43.56%)	273 (3.39%)	477 (5.92%)
Wet season	1140 (12.70%)	4709 (52.48%)	206 (2.30%)	1967 (21.92%)	731 (8.15%)	220 (2.45%)
z values	7.50**	33.30**	2.78**	30.19**	13.17**	11.40**

*: p < .05 **: p < .01

Table 2: Step-wise multiple regression on climatic variables and activity schedule of species

Step	Model	Dependent Variable	Unstandardized Coefficients B	Unstandardized Coefficients Std error	Standardized Coefficients Beta	t	Sig
I	(Constant)		-24.23	11.03		-2.20	0.06
	Temp Max	Locomotion	1.14	0.32	0.76	3.55	0.01
II	(Constant)		26.65	4.41		6.04	0.000
	Rainfall	Exploration	0.15	0.04	0.79	3.88	0.004
III	(Constant)		41.98	4.02		10.45	0.000
	Rainfall	Inactivity	-0.11	0.04	-0.72	-3.07	0.010
IV	(Constant)		50.48	12.68		3.98	0.004
	Temp Min	Self	-1.84	0.53	-0.73	-3.46	0.010
	Rainfall	Self	-0.03	0.01	-0.56	-2.64	0.030

significant negative correlations for rainfall and locomotion (r = -0.60), rainfall and inactivity (r = -0.72) and, minimum temperature and self-directed (r = -0.61). Significant positive correlations were seen for rainfall and exploration (r = 0.79), humidity and feeding (r = 0.60) and, maximum temperature and locomotion (r = 0.76). The results of a stepwise multiple regression (Table 2) on climatic variables and activity schedule showed that maximum temperature was the best predictor for locomotion, rainfall for exploration and inactivity, and minimum temperature and rainfall for self-directed behaviour. For the categories social and feeding, no variables were entered.

Feeding

Insects formed a significantly higher percentage in the diet of the slender loris (χ^2 = 876.69; df = 2; $P < 0.01$) at 91.48%, with plant material and gum forming 6.61% and 1.9% respectively. The insects consumed included ants (Hymenoptera), termites (Isoptera), stick insects (Phasmatodea), pungent smelling beetles (Coleoptera), silkworms, butterflies and moths (Lepidoptera), and several varieties of grasshoppers (Orthoptera) and slugs (Mollusca). Study individuals were seen feeding on the fruits of *Securinega leucopyrus* and *Ziziphus oenoplia.* They were also observed to stick their heads into the flowers of *Eucalyptus*, *Tamarindus* and *Agave americana* and suck at the pods of *Prosopis juliflora.* It could not be determined if they were sucking the nectar from the flowers or eating the ants in the pods and flowers. Study individuals were also seen licking gum from the bark of *Albizia* and *Acacia* trees. In a typical gum lick, the loris would cling to a tree trunk vertically, scrape at the bark with its toothcomb and lick the exposed sap. A gum lick usually lasted about two to five minutes, but in one case, a female licked gum from an *Acacia planifrons* for 15 minutes. Lorises were observed to cling vertically inside the *Euphorbia*, but it could not be ascertained if they actually licked gum from the plant.

Habitat Use

The tree and plant species most commonly used by the slender loris included *Albizia amara*, *Acacia ferruginea*, *A. planifrons*, *A. leucophloea*, *A. nilotica*, *Prosopis juliflora*, *Euphorbia tortilis*, *Agave americana*, *Azadirachta indica*, *Tamarindus indica*, *Eucalyptus grandis*,

Canthium parviflorum, *Cassia fistula*, *Cassia auriculata*, *Securinega leucopyrus*, *Commiphora berryi*, *Strychnos nux-vomica*, *Holoptelea integrifolia*, *Bauhinia racemosa*, *Ziziphus oenoplia*, *Dichrostachys cinerea* and *Ipomoea staphylina*. The four *Acacia* species (37.77%) were the main tree species used by the slender loris. The other important tree species were *Azadirachta* (15.04%), *Euphorbia* (13.10%), *Albizia* (9.92%), and *Tamarindus* (6.12 %).

Lorises used trees 3-5 m and 5-8 m tall most often and almost equally (36.36% and 37.40% respectively). They stayed most often at heights of 3-5 m (51.26%), and 1-3 m (26.62%). The height of the tree used and the level at which the loris ranged, were found to be different for males and females.

Univariate analysis of variance of tree height and the sexes showed that both adult males and females used the 3-7 m category most often (Mean: males = 80.16, females = 68.92). A significant interaction between the tree heights and the sexes (ANOVA: $F_{3, 36} = 3.93$; $P < .05$) indicated that, whereas the males used trees of 3-7 m more than the females, the females used trees of 1-3 m more than the male, (Mean of 1-3 m: females = 22.88, males = 9.61).

Univariate analysis of variance of animal height and the sexes showed that both adult males and females stayed at heights of 3-5 m most often (Mean: males = 61.43, females = 41.16). A significant interaction between the sexes and animal height (ANOVA: $F_{3, 36} = 4.41$; $P < 0.01$) indicated that, whereas males stayed at 3-5 m more than the females, females stayed at 1-3 m more than the males (Mean of 1-3 m: females = 34.71, males = 24.42).

Discussion

Activity Budgets

Slender lorises spend a large part of their activity schedule in exploration, followed by inactivity. Self and social behaviours account for very little time, hardly 10% of their activity schedule. Though the results show that the time spent on feeding is minimum, the data only comprised observed feeding instances, which are difficult to record in a small-bodied, predominantly insectivorous, cryptic animal (but see Nekaris 2000). Slender lorises do not spend most of their waking life in social contact, as has been described for pottos (Anderson 1971). Even when a mother and offspring shared the same range, there was little contact between them at night. Most of the social behaviour was restricted to dusk and dawn, when the animals met to sleep together. Sleep group formation at dawn and the split-up at dusk was usually accompanied by allogrooming and play-wrestling. Though animals did sometimes meet during the night to allogroom and play-wrestle, they were not observed meeting to groom or sleep after the first five or six hours of activity as reported by Goonan (1993). Bushbabies travel faster and cover greater distance during lighter phases of the moon, due to greater ease in navigation under better viewing conditions (Bearder pers. comm.). In the slender loris, increased exploration is seen in the darker phase of the moon. This may be related to the cryptic strategy used by the slender loris that depends on stealth and concealment for protection from predators.

In the study area, the rains of September-October caused a rise in the number of hymenopterans. Just after these rains, the *Eucalyptus*, *Acacia leucopholea* and *Azadirachta* flowered, and *Securinega* fruits appeared. This also probably caused an increase in the insect population. The increased explorations in the wet season could be attributed to these reasons. Animals were observed to continuously forage for insects in the first rain. The long foraging was followed by a long session of grooming. This explains why rainfall is a strong predictor of exploration, and to a smaller extent of self directed behaviour. Muller *et al.* (1985) suggest that the slender loris copes very

well with high environmental temperatures on account of its long and slender limbs, small size and increased heat loss through evaporation. This may explain why the species shows increase in locomotion with rise in temperature.

Feeding

Slender lorises are predominantly insectivorous (Phillips 1931, Petter and Hladik 1970, Still 1905), they also eat flowers and fruits (Roonwal and Mohnot 1977, Johnson 1984). The present study records that they also feed on gum. Gums are complex polymerised sugars with protein and trace minerals, and are consumed by small-bodied primates to survive seasonal shortages of fruits and insects, and to make up for the low calcium levels in fruits and insects (Bearder and Martin 1980, Bearder 1987). It has been proposed that slender lorises would include a large amount of toxic insect prey in their diet (Rasmussen 1986, Rasmussen and Nekaris 1998). In the present study, some amount of repugnant insects was eaten (as evidenced by the slobbering and urine-washing displayed when eating the pungent smelling beetles). But as a complete identification of insects was not done, the extent of their role in the slender loris diet is not known (but see Nekaris 2000). Slender lorises have been reported to drink milk and water in captivity, by licking it off their fingers or lapping it like a dog from the bowl (Subramoniam 1957, Schulze and Meier 1995), but the study animals were never seen to consume anything liquid. They were frequently observed to suck on the thorns of *Acacia* trees, but it could not be ascertained if they did so to obtain liquid nourishment, or feed on insect larvae (Nekaris, pers. comm.). Study animals were never observed to eat invertebrates beyond the arthropod level (but see Nekaris 2000), though slender loris have been reported to feed on baby mice, birds, and gerbils in captivity (Kinnear 1919, Phillips 1931, Subramoniam 1957, Bishop 1964).

Habitat Use

The predominant use of *Acacia* by the observed lorises is probably due to the high insect densities on these trees. *Acacia* also provides gum and plant matter. Furthermore, the thorns must also prove a deterrent to predators. Wherever *Acacia* was available, study females preferred to leave their month-old infants in these trees (pers obs.). Next to *Acacia*, *Azadirachta* and *Tamarindus* were used for parking infants (pers obs.), possibly because of their height and the insect densities they support (Singh *et al.*1999). All the major tree species used provide food and protection, either in terms of height from the ground (*Azadirachta, Tamarindus* and *Albizia)* or by way of thorns *(Acacia* and *Euphorbia*).

Slender lorises prefer to stay at heights of 3-5 m from the ground and use trees of heights 3-8 m. Nekaris (2000) observes that slender lorises used trees of mean height 5.6 m and ranged at an average height of 3.5 m. Height preference in the slender loris is probably related both to dietary requirements and safety from predators. Male slender lorises show greater locomotion than the females (Radhakrishna 2001). This probably results in them making a greater use of the connecting terminal branches found higher up in the trees. This would explain why male slender lorises tend to stay at greater heights and use taller trees more than the females.

Conclusion

These findings on activity patterns, diet and substrate use in the slender loris have important implications for its conservation. The slender loris has (a) a predominantly insectivorous diet, (b) preference for common tree species such as *Acacia*, *Azadirachta* and *Euphorbia* and (c) a high reproductive potential (Radhakrishna 2001). Several populations have also been found in close proximity to human habitations (Singh *et al.* 1999). Significant threats faced by the study population include

disturbances caused by tree felling, resulting in loss of canopy contiguity, and deaths caused by vehicular traffic (Radhakrishna 2001, Singh *et al.* 1999). If these factors could be controlled, the management of slender loris for long term survival in the wild would become easier.

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PLANT SELECTION FOR NESTING BY *OECOPHYLLA SMARAGDINA*, HYMENOPTERA: FORMICIDAE: DO PHYSICAL FEATURES AFFECT THE CHOICE OF THE PLANT?[1]

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Key words: *Oecophylla smaragdina*, weaver ant, nesting habits, plant physical features, Homoptera

The weaver ant, *Oecophylla smaragdina* Fabricius is the only species of ant in the Old World to build nests on plants by tying leaves together with silk secreted by the larvae. Although the ant is widespread in its distribution in southern India, it was not found to nest uniformly across its range of distribution. One possible reason for such a variation could be the lack of suitable plants for nesting. Investigations, therefore, were made on the suitability of plants, on the basis of selected physical parameters, to check their influence on the choice of plants for nesting by *O. smaragdina*.

A total of 498 plants belonging to 51 species were examined for the occurrence of nests of *O. smaragdina* in and around the GKVK campus of the University of Agricultural Sciences, Bangalore. A total of 124 nests were located on 19.61% of the species of plants examined, indicating that the ants do not nest on all species of plants. Fourteen physical characters (of leaf or twig) measured either as qualitative or quantitative data, were not found to influence the nesting pattern of the weaver ant. Therefore, the observed variation in nesting pattern may be attributed to other non-physical factors of the plants. The chemistry of the plants or the micro-habitat, i.e. the location of the plant, may influence the nesting pattern of *O. smaragdina.*

Introduction

The weaver ant, *Oecophylla smaragdina* F. is the only member of the tribe Oecophyllini (Formicidae: Formicinae) found in the Old World and is widely distributed in perennial cropping systems throughout southern India. It is considered a nuisance and a pest of many cultivated crops, as it harbours noxious homopterans such as coffee green scales (Hill 1983) for honeydew. On the other hand, its use as a biocontrol agent in several cropping systems is widely appreciated (Way and Khoo 1992). Elsewhere, it is considered a dominant ant, which can influence the structure of the ant mosaic (Majer 1993) and the diversity of many other arthropods, because it is a carnivore. Though similar evaluations are lacking in India, it is undoubtedly a dominant species in many cultivated and natural perennial systems, particularly along the Western Ghats.

The ant builds the nest by tying leaves with silken threads produced by the ant's own larvae. Some worker ants form a chain to connect the leaves of the plant and then pull them together, so that the margins of the leaves overlap. Other workers bring the advanced stage larvae close to the overlapping edges and move them criss-cross across the edge to seal it. Nest construction using leaves appears to be a continuous process, as nests of all sizes can be found on different parts of the plant (Holldobler and Wilson 1990). The nest is expanded by joining more leaves to increase its volume, which also results in the formation of different enclosures within the nest. Although the ant is known to build nests on a wide variety of plants, the plant factors that influence the ant's colonisation pattern have been little studied. It is believed that the ant prefers evergreen, broad-leaved plants to construct nests (Bingham 1903).

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However, the congeneric *O. longinoda* is known to prefer many cultivated plants for nesting. The order of preference shows a strong preference for mango over other cultivated species tested by Djieto-Lordon and Dejean (1999), who did not investigate the characteristics of plant or leaves in relation to the nesting preference of the species. The choice of a plant for nesting is likely to be influenced by both the physical and chemical features of the plant. In this study, we tested some physical features of the plant for their possible role in influencing the nest plant selection by of *O. smaragdina*.

Material and Methods

A total of 498 plants belonging to 51 species in 24 families were examined for nests of *Oecophylla smaragdina* in and around GKVK campus, University of Agricultural Sciences, Bangalore (Table 1). Fourteen physical characteristics of the plants were recorded, in qualitative or quantitative measures. The occurrence of *O. smaragdina* on 51 species of plants measured qualitatively (presence/absence) was checked for association with eight of the fourteen qualitative measures of plants. These included type of plant (shrub/tree), presence/absence of thorns, arrangement of leaves, shape of leaf, texture of leaf, simplicity of leaf, petiolate/sessile leaves and smoothness of leaf margin. The characters measured quantitatively were number of leaflets, internodal length, number of twigs per metre, size of leaf (length, breadth, area). The quantitative measures, grouped into 5-7 classes and the corresponding number of plant species with *O. smaragdina* nests were tabulated. The occurrence of Homoptera colonies on the plants was also recorded.

The qualitative characters were tested for association using 2 x 2 contingency Chi-square. Quantitative characters were divided into 5, 6, or 7 classes, considering the range. Proportional occurrence of plants with and without the nests in each size class was noted. Using the cumulative values of proportional occurrence of plant species in the two categories χ^2 of K-S test (Kolmogorov-Smirnov test, Siegel 1956) for two large samples was then computed to ascertain whether the two distributions differed. Lack of difference would suggest that plants with nests are distributed in all size classes of the character considered and match the natural distribution of the characters in the community. For all these tests, any species with at least one nest, irrespective of the number of plants surveyed, was taken as a plant with nests.

Results

Occurrence of *O. smaragdina* on plants: In all, 124 nests of *O. smaragdina* were located on 34 plants belonging to 10 species spread over 6 families (Table 2). This amounted to 6.83% of plants, 19.61% of species and 25% of families of plants surveyed, indicating that these ants do not nest uniformly on all plant species. Mango, pongamia, tabebuia, cocoa, syzigium, coffee and four unidentified plants were found to harbour ant nests and the percentage plants with nests followed the same order.

Physical features of the Plant: Among the plants observed, 24 species were shrubs and 6 of them harboured nests. Similarly, 27 species were trees and 4 harboured weaver ants. All the ten species of plants with nests were found to be thornless. Five of the plants with nests had opposite leaves while the remaining had alternate leaves. The ants were observed to nest on plants with both simple and compound, petiolate leaves, but only two were in the latter category. Six of the plants with nests had elongate leaves, while four had oval leaves. All these ten plants had smooth leaf margin and only one had leaves with a rough surface. The details of qualitative characters and plants exhibiting them are included in Table 3. All the ten plants with nests were found within the range of five leaflets per

Table 1: Plant species screened for the occurrence of *Oecophylla smaragdina* in and around GKVK, Bangalore

Sl. No.	Name	Common name	Family	No. of plants examined	No. of trees with nests	Total No. of nests	% plants with nests	Mean No. of nests\tree
1	*Tabebuia argentea*	Tabebuia	Bignoniaceae	23	7	9	30.43	0.39
2	*Cocos nucifera*	Coconut	Palmaceae	66	0	0	0	0
3	*Leucaena leucocephala*	Subabul	Fabaceae	123	0	0	0	0
4	*Pongamia glabra*	Pongamia	Fabaceae	24	8	50	33.43	2.08
5	*Psidium guajava*	Guava	Myrtaceae	2	0	0	0	0
6	*Coffea robusta*	Coffee	Rubiaceae	16	1	3	6.25	0.18
7	*Theobroma cacao*	Cocoa	Sterculiaceae	5	1	2	20.00	0.40
8	*Elaterium cardamomum*	Cardamom	Zingiberaceae	12	0	0	0	0
9	*Erythrina indica*	Erythrina	Fabaceae	14	0	0	0	0
10	*Mangifera indica*	Mango	Anacardiaceae	16	8	30	50.00	1.87
11	*Gliricidia maculata*	Gliricidia	Fabaceae	9	0	0	0	0
12	*Grevillea robusta*	Silver oak	Proteaceae	4	0	0	0	0
13	*Ficus bengalensis*	Ficus	Moraceae	3	0	0	0	0
14	*Syzygium cumini*	Jamun	Myrtaceae	17	3	12	17.64	0.70
15	*Santalum album*	Sandal	Santalaceae	3	0	0	0	0
16	*Anacardium occidentale*	Cashew	Anacardiaceae	7	0	0	0	0
17	*Eucalyptus hybrida*	Eucalyptus	Myrtaceae	5	0	0	0	0
18	*Brassaia actinophylla*	Umbrella tree	Araliaceae	2	0	0	0	0
19	*Agave* sp.	Agave	Agavaceae	1	0	0	0	0
20	*Bambusa arundinacea*	Bamboo	Graminae	12	0	0	0	0
21	*Roystonea regia*	Bottle palm	Arecaceae	19	0	0	0	0
22	*Araucaria columnaria*	Christmas tree	Pinaceae	2	0	0	0	0
23	*Thuja occidentalis*	Thuja	Cupressaceae	5	0	0	0	0
24	*Pinus* sp.	Pine	Pinaceae	2	0	0	0	0
25	*Tamarindus indica*	Tamarind	Fabaceae	2	0	0	0	0
26	*Albizia* sp.	Albizia	Mimosaceae	4	0	0	0	0
27	*Anona squamosa*	Custard apple	Annonaceae	1	0	0	0	0
28	*Bauhinia purpurea*	Bauhinia	Caesalpiniaceae	2	0	0	0	0
29	*Azadirachta indica*	Neem	Meliaceae	8	0	0	0	0
30	*Averrhoa carambola*	Carambola	Averrhoaceae	1	0	0	0	0
31	*Ailanthus excelsa*	Match wood tree	Simaroubaceae	2	0	0	0	0
32	*Plumeria alba*	Temple tree	Apocynaceae	1	0	0	0	0
33	*Tectona grandis*	Teak	Verbenaceae	3	0	0	0	0
34	Unidentified sp1			1	0	0	0	0
35	Unidentified sp2			7	1	3	14.28	0.42
36	Unidentified sp3			1	0	0	0	0
37	Unidentified sp4			1	0	0	0	0
38	Unidentified sp5			7	1	1	14.28	0.14
39	Unidentified sp6			18	3	8	16.66	0.44
40	Unidentified sp7			4	0	0	0	0
41	Unidentified sp8			1	0	0	0	0
42	Unidentified sp9			1	0	0	0	0
43	Unidentified sp10			7	0	0	0	0
44	Unidentified sp11			2	0	0	0	0
45	Unidentified sp12			2	0	0	0	0
46	Unidentified sp13			1	0	0	0	0
47	Unidentified sp14			1	1	6	100.0	1.00
48	Unidentified sp15			11	0	0	0	0
49	Unidentified sp16			1	0	0	0	0
50	Unidentified sp17			2	0	0	0	0
51	Unidentified sp18			12	0	0	0	0

Table 2: Occurrence of *Oecophylla smaragdina* nests on plants

	Oecophylla Nests				
	Present	Percent	Absent	Percent	Total
No. of plants	34	6.83	464	93.17	498
No. of species	10	19.61	41	80.39	51.00
No. of families	6	25.00	18	75.00	24

Table 3: Association between qualitative characters of plants and nesting by *Oecophylla smaragdina* at GKVK Campus

Plant character	Plant with nest	Plant without nest	Chi-square	Significance P<0.05
Type of plant				
Shrub	6	18	0.314	NS
Tree	4	23		
Thorns				
Present	0	4	0.139	NS
Absent	10	37		
Arrangement of leaves				
Opposite	5	18	0.00005	NS
Alternate	5	23		
Type of leaves				
Simple	8	24	0.799	NS
Compound	2	17		
Petiolated condition				
Petiolate	10	31	0.574	NS
Sessile	0	10		
Shape of leaves				
Elongate	6	25	0.092	NS
Oval	4	16		
Texture of leaves				
Smooth	9	25	0.968	NS
Rough	1	13		
Leaf margin				
Smooth	10	34	0.044	NS
Rough	0	7		

leaf and 37 species of plants without nests had the leaflet numbers in this range. The internodal lengths varied from <1 to 19 cm among the studied plants. These were divided into 6 different classes and all of them were represented among the plants with ants. Number of twigs per metre of the stem ranged up to 60 and was divided into five classes, which were all represented by the plants with nests. Leaf or leaflet length varied from 0.5 to 46.83 cm and the plants could be divided into 7 different classes and all of the categories were represented by plants with ant nests. Similarly, leaf breadth and the leaf area showed considerable variation among the plants checked for ant nests. The plants could be divided into five and six classes with respect to breadth and area respectively. Ants were found on plants of all categories. A summary of these quantitative characters is provided in Table 4.

Nest occurrence and plant characters: The distribution of the fourteen characters among the plants with nests matched the natural distributions of these characters among the 51 species of plants surveyed (Chi-square: 0.5×10^{-4} to 2.62; $p>0.05$ for all the characters). Clearly, the tests indicated that the physical features of the plants considered were not influencing the choice of nesting by the weaver ants (Table 3 & 4).

Table 4: Association between quantitative characters of plants and preference for nesting by *Oecophylla smaragdina* at GKVK Campus

Character	Range	Mean	Chi-Square	Probability <0.05
No. of leaflets/ leaf	3-208	105.50	2.62	NS
Internodal length	0.2-19 cm	9.60	1.47	NS
No. of twigs/m	1-60	30.50	0.55	NS
Leaf length	0.5-46.83 cm	23.66	0.48	NS
Leaf breadth	0.3-17.5 cm	8.90	0.48	NS
Leaf area	0.33-342.2 sq. cm	171.30	0.56	NS

Ants and Homoptera on plants: Colonies of homopterans were found on 29 species of plants. All the plants with ant nests were found to harbour Homoptera, including aphids, scales, mealy bugs and tree-hoppers. The ants were observed to tend only scales and mealy bugs. The association test indicated that ant occurrence is strongly dependent upon the availability of homopteran colonies on the plants (Chi-square: 6.01; $p<0.01$).

Discussion

There has been no evaluation of the role of physical characters of plant in the nesting preference of *O. smaragdina*. The present study shows that physical parameters of the plants considered do not influence the choice of nest plant. Earlier observations indicated that weaver ants nest exclusively on broad-leaved evergreen plants (Bingham 1903). However, in the present study, the ants were recorded on deciduous plants such as Pongamia and on other species which have very small leaflets e.g., *Albizia* sp. Although the study considered only two types of plants i.e. shrubs and trees, it is likely that vines may also be colonised. This study showed that the ants have no preference for plants with specific physical characteristics for nesting. Reasons for the absence of nests on most of the plants species screened could not be established in this study. The occurrence of *O. smaragdina* on plant species may be governed by factors other than their physical features. For example, the nesting efficiency may be influenced by the amount of silk the larva needed to produce to bind the leaves together, as smaller leaves require greater quantities of silk and energy, at the cost of the development of the colony. Yet, such characters were not found to influence the nesting pattern. Clearly, the cost of such nest building may be offset by other benefits that the ant may get from plants with small leaves. This is evident from the strong association observed between the ant nests and the Homopteran colonies among the plants screened.

If physical parameters of the plants are not influencing the nest building on plants, then what other factors govern the *O. smaragdina* nest distribution on plant species? There is some indirect evidence to support the possibility of nest construction by *O. longinoda* being influenced by prior experience of the larvae with the plants (Djieto-Lordon and Dejean 1999). The experience of nesting on a plant could be imprinted in the larvae by chemical signals. Therefore, it is likely that the chemical features of the plants play the most important role in selection for nesting by *O. smaragdina*. But not all plants were uniformly inhabited even among the preferred plants, which suggests other factors like the micro-habitat of the plant as one possible reason to affect the nesting. However, the occurrence of ant nests was strongly associated with the occurrence of Homoptera, particularly scale insects. This suggests that the host plants of these scales may be the most important hosts of the weaver ants. But *O. smaragdina* being a predatory ant, such a strong association between the Homoptera and the ants is surprising. It is possible that the honeydew of the Homoptera is essential for the survival and multiplication of the ants. These aspects of the biology of *O. smaragdina* may be of help in managing them, either in biological control or to reduce their impact as pests of economic importance.

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STATUS OF BENGAL FLORICAN *HOUBAROPSIS BENGALENSIS* IN ROYAL BARDIA NATIONAL PARK, NEPAL[1]

(*With two text-figures*)

NABIN BARAL, BIJAY TAMANG AND NILESH TIMILSINA[2]

Key words: *Houbaropsis bengalensis*, status, grassland management, population decline, Bardia, Nepal

A survey for the endangered Bengal florican (*Houbaropsis bengalensis*) was carried out in April-May 2000 in some grassland sites of the Royal Bardia National Park, Nepal. A total of 5 floricans (3 males and 2 females) were counted in 11 days. All the males had distinct territories. Though limited suitable florican habitat was available, the population seemed to be declining. To provide additional habitat for floricans, proper maintenance of grasslands in areas other than Bagaura and Lamkauli has been recommended.

INTRODUCTION

Bengal florican (*Houbaropsis bengalensis*), one of the three bustard species endemic to the Indian subcontinent, has undergone an alarming decline throughout its former range, as its grassland habitat has been lost to cultivation, afforestation or degraded by overgrazing (Rahmani *et al.* 1991). Its past distribution ranged from southern Uttaranchal (earlier northwestern Uttar Pradesh) to Upper Assam, through the Nepal terai, Bengal duars and Brahmaputra Valley (Ali and Ripley 1969, Rahmani *et al.* 1991). The known population of less than 300-400 individuals is at serious risk from further habitat loss, warranting its inclusion in the IUCN list of endangered species.

In Nepal, a preliminary study initiated by ICBP (now BirdLife International), in 1982, located 35-50 floricans distributed in five sites: Royal Chitwan National Park (RCNP), Royal Bardia National Park (RBNP), Royal Suklaphanta Wildlife Reserve (RSWR), Koshi Taapu Wildlife Reserve (KTWR) and an unprotected area near the Koshi barrage in east Nepal (Inskipp and Inskipp 1983). The Koshi barrage site appears to have lost its small population after 1980, following a change in the course of the Koshi river. There has been no record from KTWR since 1990.

The rapid population growth and urbanization in the Nepal *terai* has resulted in all unprotected grasslands being converted to cultivated land, with grasslands now existing only inside protected areas. Records from the past two decades indicate a decline in the population of the Bengal florican. Hunting does not seem to be the cause, since the species is well-protected, and punishment for poaching is severe. Decrease in the extent of grasslands and the improper management of some could be major causes for its decline. This paper aims to present the current information on the status and distribution of the Bengal florican in the Royal Bardia National Park.

STUDY AREA

The Royal Bardia National Park (28° 38' N and 81° 20' E) is located *c.* 450 km southwest of Kathmandu in southwestern Nepal, and occupies an area of 968 sq. km. It has a sub-tropical climate, with three seasons: the hot-dry from mid February to mid June, monsoon from mid June to late September and cool-dry from late September to mid February (Dinerstein

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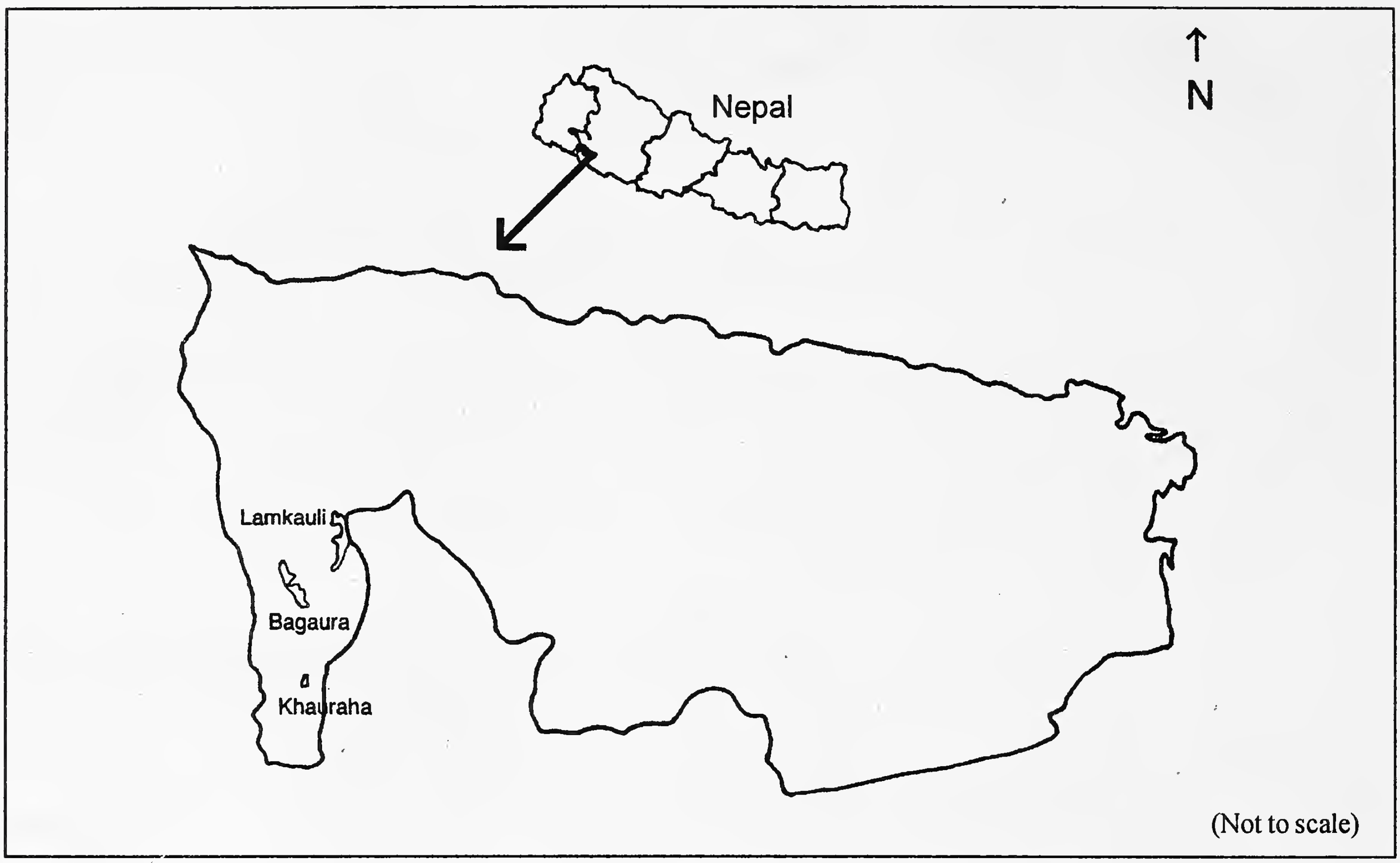

Fig. 1: Map of Royal Bardia National Park

1979a). About 80-90% of the total annual rainfall occurs during the four months period from June to September. The average annual rainfall of the Park is 2,168 mm.

The Park holds a great variety of flora and fauna. Some 32 large mammals (Dinerstein 1979b) and 235 bird species (Inskipp 1983) have been recorded. The vegetation of the Park was classified into six major types by Dinerstein (1979a), and modified by Jnawali and Wegge (1993) to seven major types. The vegetation types are *Shorea robusta* forest, *Acacia-Dalbergia* forest, woody grasslands, floodplain grassland and phantas. Phantas are previously cultivated fields, which have been restored to open grasslands after being included in the Park. The three phantas: Lamkauli, Bagaura and Khauraha were the main areas under study (Fig 1). These phantas are dominated by *Imperata cylindrica*, *Saccharum spontaneum* and *Narenga porphorycoma*. The Khauraha phanta has lost its open grasslands to succession by invading trees and bushes. Some grassy patches inside and outside the Park were also studied.

Methodology

Known florican habitats were visited during the breeding season (April-May), when the territorial males are easily seen during their aerial display. As Bengal floricans are most active in the early mornings and evenings (Ali and Ripley 1969), observations were carried out mainly in the early mornings (0630-1000 hrs) and late afternoon (1630-1900 hrs). Floricans are territorial during the breeding season when each individual male defends a patch of grassland (Ali and Rahmani 1982-84, Sankaran and Rahmani 1986), so the number of territories or display sites in an area indicates the population of adult male floricans. As hens are not easy to locate, the population estimates are based on the assumption

of equal sex ratio. Observations were made using binoculars from machans for a better view of the grasslands. Some areas were also covered on elephant back. The number of floricans seen, their sexes, activity, time, weather and time spent in each area were noted. Notes were taken on the general condition of the grasslands and disturbances.

Group discussions were held with the Park officials, game scouts and local people to gather information on the presence and conservation related issues of the Bengal florican.

Results

The present study recorded five floricans (3 males and 2 females). Two males and two females were recorded in Lamkauli phanta and one male was recorded in Bagaura phanta. Sub-adults, eggs and chicks were not recorded (Table 1). All the male floricans observed were occupying short grass patches, whereas the females observed in Lamkauli occupied the tall grass area by the side of the motorable road. Because the grass was short and the visibility good, the study assumes that all the floricans present were recorded.

There was no overlapping of territories between the males. All the male birds observed on the ground were also seen in flight, but the females were never seen flying.

Earlier studies suggested the presence of Bengal florican in Khauraha phanta (pers. comm., Park staff), but this survey was unable to record any. Successive changes have resulted in encroachment of grasslands by trees, bushes and tall grass species and this might have made the Khauraha habitat unsuitable for the floricans.

Table 1: Bengal florican recorded in Royal Bardia National Park, 2000

Site	Days spent	No. of visits	Male	Female	Sub-adult
Lamkauli	4	7	2	2	-
Bagaura	3	6	1	-	-
Khauraha	3	6	-	-	-
Other places	2	3	-	-	-
Total	11	22	3	2	-

Most of the small grass patches and probable florican habitats inside and outside the Park were surveyed, but no florican was seen.

The habitat in Bagaura and Lamkauli phanta seemed to be ideal for the florican. *Imperata cylindrica* among the short and *Saccharum* sp. among the tall grass species dominated both the phantas. Male floricans preferred the *Imperata* patch and females the *Saccharum* patch. Grass height ranged from 17-110 cm, and it provided sufficient cover and shelter. Khauraha could be an ideal habitat for Bengal florican, but needs rigorous management.

Inskipp (1983) reported 9-10 floricans (8-9 males and 1 female) in Bardia and Weaver (1991) reported 6 birds (5 males and 1 female). The current population of 3 males and 2 females when compared to the earlier records shows a decline in population.

Discussion

In most studies conducted in Bardia, sub-adult floricans were not sighted. This may indicate some recruitment problem, either due to poor breeding or low survival rate of young; the availability of suitable habitat could be one of the main problems. The population of florican has declined over the past two decades, so it is important to address the problems related to grassland habitat to increase their population. We do not know the viable population size for long-term survival, but maintaining a healthy population in all the present habitats is crucial for the conservation of the species.

Grassland management is necessary to maintain the florican habitat. In Bardia, grasslands undergo annual controlled burning

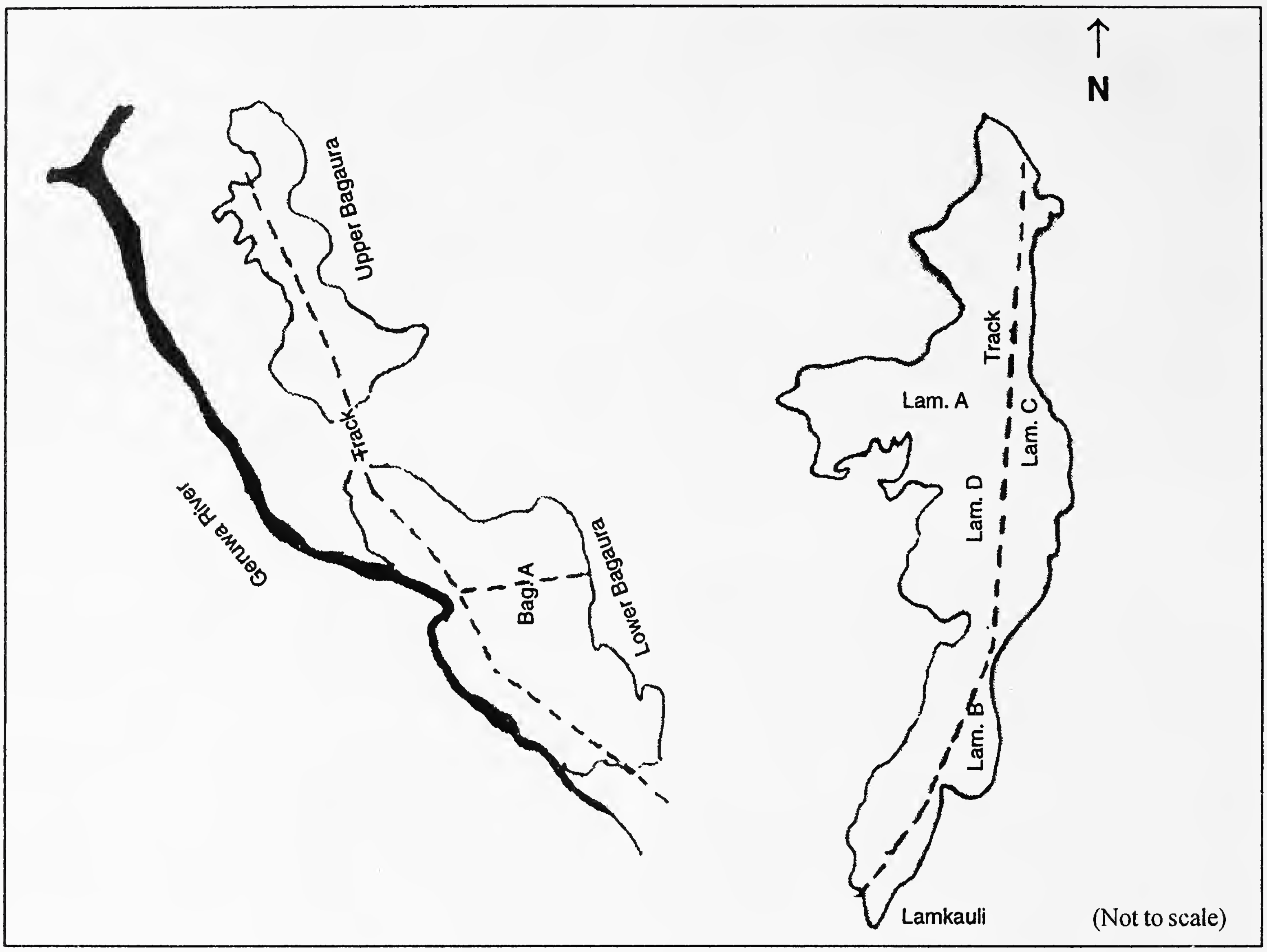

Fig. 2: Map of Bagaura and Lamkauli phanta showing distribution of Bengal florican

in January and February. In December, the local villagers are allowed to enter the protected areas and cut grass for thatch. Normally, January and February seems to be the correct time for the burning of grass in Bardia, but the record of a displaying male (Inskipp and Inskipp 1983) in December suggests that the breeding season should be avoided while burning or harvesting. If burning is carried out during the breeding season, it could destroy eggs or young birds. Ideally, burning should be done in small patches before the breeding season. All the patches should not be burned every year. Extensive dry season burning should be strictly avoided.

There was no hunting pressure as the species is listed and hunting is strictly prohibited. Grasslands near the Park and near human settlements were overgrazed, and also suffered from anthropogenic pressures.

The space needed for territory formation of a large population of floricans is currently lacking in Bardia.

RECOMMENDATIONS

1. Steps should be taken to prevent invasion by tree saplings. Burning and harvesting in grasslands should be strictly regulated.

2. Locals should be made aware of the different aspects of florican and grassland conservation.

3. Very little is known about the ecology of the Bengal florican outside its breeding season. Radiotelemetry should be used to study the movement of floricans outside the breeding season.

4. Healthy populations of wild ungulates, to some extent, help in maintaining grassland habitat. Interaction of Bengal florican with other grassland species could be studied, and the conservation strategy should protect all the grassland species originally found in the area.

5. Florican population in all prime habitats should be monitored annually.

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ABUNDANCE AND DIVERSITY OF MOSS COMMUNITIES OF CHOPTA-TUNGANATH IN THE GARHWAL HIMALAYA[1]

(*With seven text-figures*)

HANS RAJ NEGI[2]

Key words: Alpha-diversity, beta-diversity, macrohabitats, microhabitats, moss, taxon rank surrogacy, Tunganath, Garhwal Himalaya

A total of 8,155 colonies of moss from 12 plots of 50 m x 10 m, from four vegetation (macrohabitat) types along gradients of disturbance and elevation (1,400-3,700 m) in the Chopta-Tunganath landscape of the Garhwal Himalaya, yielded 34 families with 87 genera and 177 species. *Thuidium cymbifolium*, *Entodon rubicundus*, and *Racomitrium subsecundum* were wide-niche species, occupying all the three major substrates (microhabitats), namely rock, soil and wood, whereas *Tetraplodon mnioides* and *Timmia megapolitana* were rare, encountered only once during the survey. Macrohabitats and microhabitats were compared with respect to alpha- and beta-diversity of the moss flora. Amongst the macrohabitats, the high altitude (2,900-3,200 m) *Rhododendron* forest had the richest moss communities followed by the middle altitude (2,500-2,800 m) *Quercus* forest, higher altitude grasslands (3,300-3,700 m) and then the lower elevation (1,500 m) *Quercus* forest. Amongst the microhabitats, soil was richer than wood and rock substrates. Species, genus and family level, alpha- as well as beta-diversities were significantly correlated with each other, implying that the higher taxonomic ranks such as genera may be used as surrogates of species for effective periodic monitoring and assessment of moss biodiversity. While unregulated human activities such as excessive fuel wood collection, tourism and fire may adversely affect the diversity of moss, seasonally regulated livestock grazing seems to have no marked impact.

INTRODUCTION

While there has been an appreciable progress in the taxonomic listing and descriptions of species of moss communities during the last three decades (Gangulee 1969-72, Chopra 1975, Kumar and Chopra 1981), the research on their community ecology, quantifying patterns of abundance, diversity and its conservation has only recently begun (Negi and Gadgil 1997, Negi 1999, Negi 2000). Notably enough, much of the past work on biodiversity patterns and processes have been descriptive and concentrated at the regional and global scales (Heywood 1995, Gaston 1996). This paper attempts to present the local scale patterns, particularly abundance, and alpha and beta diversities in moss communities across the gradients of macrohabitats (vegetation types) and disturbance along the altitude, in a landscape of about 500 sq. km, of Chopta-Tunganath in Garhwal Himalaya. Emphasis is given on understanding the local scale patterns, because land-use decisions and management policies are most often implemented only at this level (Ricklefs and Schluter 1993, Negi 1999). The study further examines the efficacy of using higher taxon ranks such as genera as reliable surrogates of species for effective periodic monitoring of the moss diversity. Conservation implications are also discussed.

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STUDY AREA

Chopta-Tunganath (30° 20' - 30° 35' N and 79° 10'-79° 20' E; 1,400 m-3,700 m) is a mountainous landscape spreading over 500 sq. km

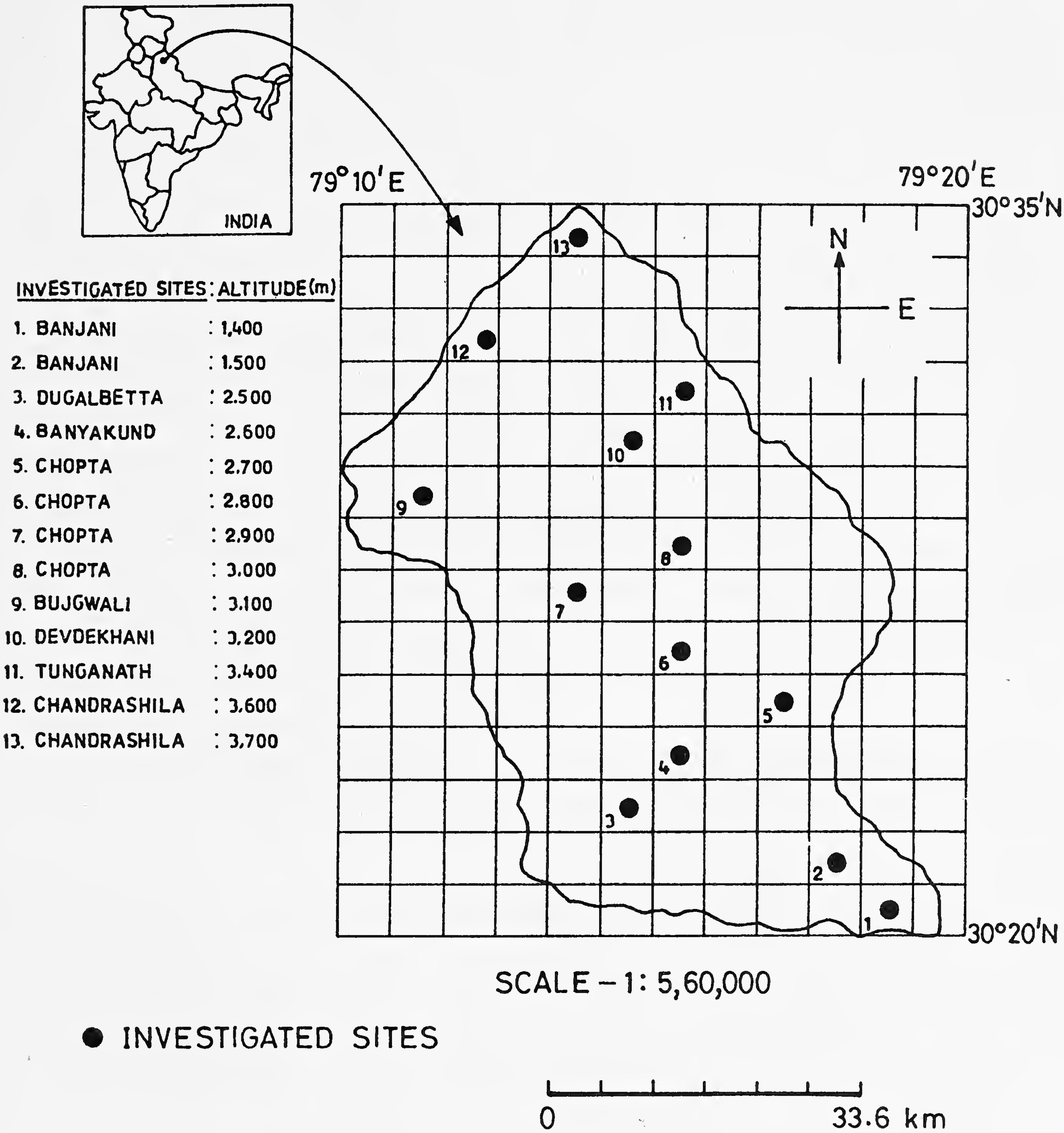

Fig. 1: Location of Chopta-Tunganath landscape

in the Indian Garhwal Himalaya (Fig. 1). The undulating topography of the area provides a variety of edaphic conditions, resulting in a distinctive flora and fauna (Gupta 1964).

The soil is coarse, well drained and acidic, at pH 4 - 5.5 (Sundriyal 1992). There is no detailed analysis of rainfall variation at different sites along the gradient. The average annual precipitation at Okhimath station (30° 30' N; 79° 15' E; 2,500 m), about 10 km west of Chopta, was 1,888.5 ±98.5mm for the last 50 years, with low to heavy snow fall from December to March. The maximum monthly temperature varies between 19-37 °C, from the higher altitude

grasslands to the lower elevation *Quercus* forests, respectively, from May to October. The minimum temperature drops to -15 °C in the alpine grasslands in December up to February.

The vegetation of the study area is broadly classified as temperate mixed oak and coniferous forests, sub-alpine forest, alpine scrub and grasslands. The area harbors more than 250 vascular plant species (Semwal and Gaur 1981) and 92 species of lichens (Upreti and Negi 1998) besides a rich diversity of fauna including the highly endangered musk deer (*Moschus chrysogaster*) (Negi 1996). The low elevation woodlands such as *Quercus* forests are open to fodder and fuel wood collection throughout the year. In the sub-alpine forests and alpine meadows, livestock grazing and tourism starts in early June, reaching a peak in July-August and stopping in early October.

METHODS

Field Sampling Design: The landscape was stratified into five macrohabitat types, based on the predominant vegetation cover along the gradient 1) Paddy fields; (<1,400 m). 2) Lower altitude (1,500 m) broad-leafed forest; dominated by *Quercus leucotrichophora*. This forest has been protected, from felling by locals, for more than 25 years. 3) Middle altitude (2,500-2,800 m) broad-leafed forest; dominated by *Quercus semecarpifolia*. 4) High altitude (2,900-3,200 m) mixed forests with dominant broad-leafed species e.g. *Rhododendron arboreum* and *Rhododendron campanulatum*, dotted with a few coniferous trees of *Abies pindrow* and *Taxus buccata*. 5) Higher altitude (3,400-3,700 m) grasslands dominated by herbaceous species, e.g. *Anemone*, *Potentilla*, *Aster*, *Geranium*, *Meconopsis*, *Primula* and *Polemonium*, and pockets of shrubs of *Rhododendron anthopogon* and *Juniperus* sp. All the macrohabitat types were exposed to varied degrees of human interference such as rice cultivation in the low land terraces, fuel wood collection from woodland, and seasonal livestock grazing and tourism in the alpine meadows.

Data Recording: 12 plots of 50 m x 10 m, were laid between 1,500 m to 3,700 m above msl,

Table 1: Attributes of 12 plots (50 x 10 sq. m) sampled for mosses and woody plants in Chopta-Tunganath

				Mosses				Woody plants	
Plot No.	Site name	Altitude (x 100 m)	MAC type	Colonies	Species	Genera	Families	Individuals	Species
1	Banjani	15	LQ	508	29	21	14	58	3
2	Dugalbetta	25	MQ	540	31	27	18	7	3
3	Banyakund	26	MQ	1126	47	37	21	9	6
4	Chopta	27	MQ	368	43	33	18	10	3
5	Chopta	28	MQ	330	29	24	16	17	2
6	Chopta	29	HR	732	52	36	20	10	3
7	Chopta	30	HR	681	56	38	19	53	9
8	Bujgwali	31	HR	604	63	41	24	24	9
9	Devdekhani	32	HR	835	29	25	13	16	3
10	Tunganath	34	HG	890	29	24	19	0	0
11	Chandrashila	36	HG	990	26	24	16	19	4
12	Chandrashila	37	HG	551	36	32	18	12	2

MAC = Macrohabitat, LQ = Lower altitude *Quercus* forest, MQ = Middle altitude *Quercus* forest, HR = High altitude mixed forest of *Rhododendron*, HG = Higher altitude grassland

covering four types of macrohabitat (Table 1). Paddy fields at 1,400 m were excluded from the sampling, as they supported few moss colonies. Three major substrates, namely rock, soil and wood, were selected as microhabitats. The woody substrates included tree trunks, branches, twigs, logs and stumps. Search and collection of all the moss colonies was carried out in each plot from June-October in 1994-95. Representative samples from each colony were preserved in bamboo paper pouches (30 cm x 30 cm). Species level identifications were made with the help of a moss taxonomist at the Botanical Survey of India (BSI). The taxonomy was based mainly on the keys by Chopra (1975) and Gangulee (1969-72). The specimens which could not be identified to the species level were either considered as distinct yet anonymous species (sp.), or assigned to a species which the majority of its structural and ecological characteristics resembled (cf.). Voucher samples of all the recorded species from the study area were preserved in the Herbarium of BSI. The numbers of trees above 10 cm girth at 130 cm height above ground and patches of shrubs (>10 cm height) in all plots were also noted. Although the mosses could not be sampled on trees above a height of 2.5 m, many canopy species were collected from fallen branches and twigs.

Data analysis

Alpha-Beta Diversity: Alpha-diversity was measured as number of species, genera or families of mosses per plot (Whitaker 1972).

Compositional change of species, genera or families from one plot to another (beta-diversity or turnover) was calculated as a Chord-distance or dissimilarity index, preferred over Jaccards similarity index (Ludwig and Reynold 1988). The former index is more robust, as it uses abundance information also, whereas the latter requires only the presence - absence data.

Chord distance between j^{th} and k^{th} plots is given as:

$$D_{jk} = \sqrt{2\left[1 - \frac{\sum_{i=1}^{S_j} N_{ij} \sum_{i=1}^{S_k} N_{ik}}{\sum_{i=1}^{S_j} N_{ij}^2 \sum_{i=1}^{S_k} N_{ik}^2}\right]}$$

Where, N_{ij} and N_{ik} are the numbers of colonies of i^{th} taxon in j^{th} and k^{th} plots, S_j and S_k are the numbers of species, genera or families in j^{th} and k^{th} plots respectively.

The dissimilarity (distance) values vary from 0 to 1.42, for pairs of plots corresponding with having none to completely dissimilar taxonomic composition. The matrix of the dissimilarity values for all pairs of plots was subjected to simple linkage cluster analysis and depicted as a dendrogram after re-scaling the values between 0 to 1 (Mark and Roger 1984).

Rarefaction: Sampling effort in terms of number of moss colonies across macro as well as microhabitats were highly unequal. I have, therefore, employed rarefaction process to compare these habitats for richness of moss diversity. How many species, genera or families do we get for an equal number of colonies sampled from each habitat type? Rarefaction addresses this question, and involves linearly increasing the number of colonies drawn from the pooled data (i.e. all the colonies in a particular habitat type) and the numbers of species, genera and families encountered were recorded. The above process was repeated 100 times, using computer simulations and the mean numbers of species, genera and families were calculated for a number of colonies sampled from each habitat type.

Regression model and simulations: A simple linear regression model was used to interpret the data on the relationships among species, genus and family level alpha and beta diversities. Since the beta-diversity values are not independent of each other, there is every possibility that the observed relationships may have occurred by chance. Moreover, this causes uncertain degrees of freedom while establishing the magnitude of the relationship. To overcome this problem, computer simulations based on randomization process were employed. The beta-diversity values in one of the pairs of taxonomic hierarchy (species, genus or family level) were scrambled with respect to the other, thus randomizing the process and **r** was calculated. This procedure was repeated 1,000 times for each pair yielding 1,000 values of **r**. Level of significance value (p) was calculated as a proportion of the simulated values of **r** that were greater than the observed **r**. Thus, the relationship with **r** value at $p < 0.005$ arrived after simulations was considered significant.

Results

A total of 34 families with 87 genera and 177 species from 8,155 colonies sampled over 6,000 sq. m, constituted the moss community of Chopta-Tunganath. The moss taxa, their occurrence on the major substrates namely rock, soil and wood, elevation range and average abundance per sampled plot are given in Table 2. The distribution of numbers of species, genera and families on these three substrates are depicted in the form of Venn diagrams (Fig. 2). 31.67% of the species, 19.54% of the genera and 17.64% of the families were terricolous (on soil). 17.51%

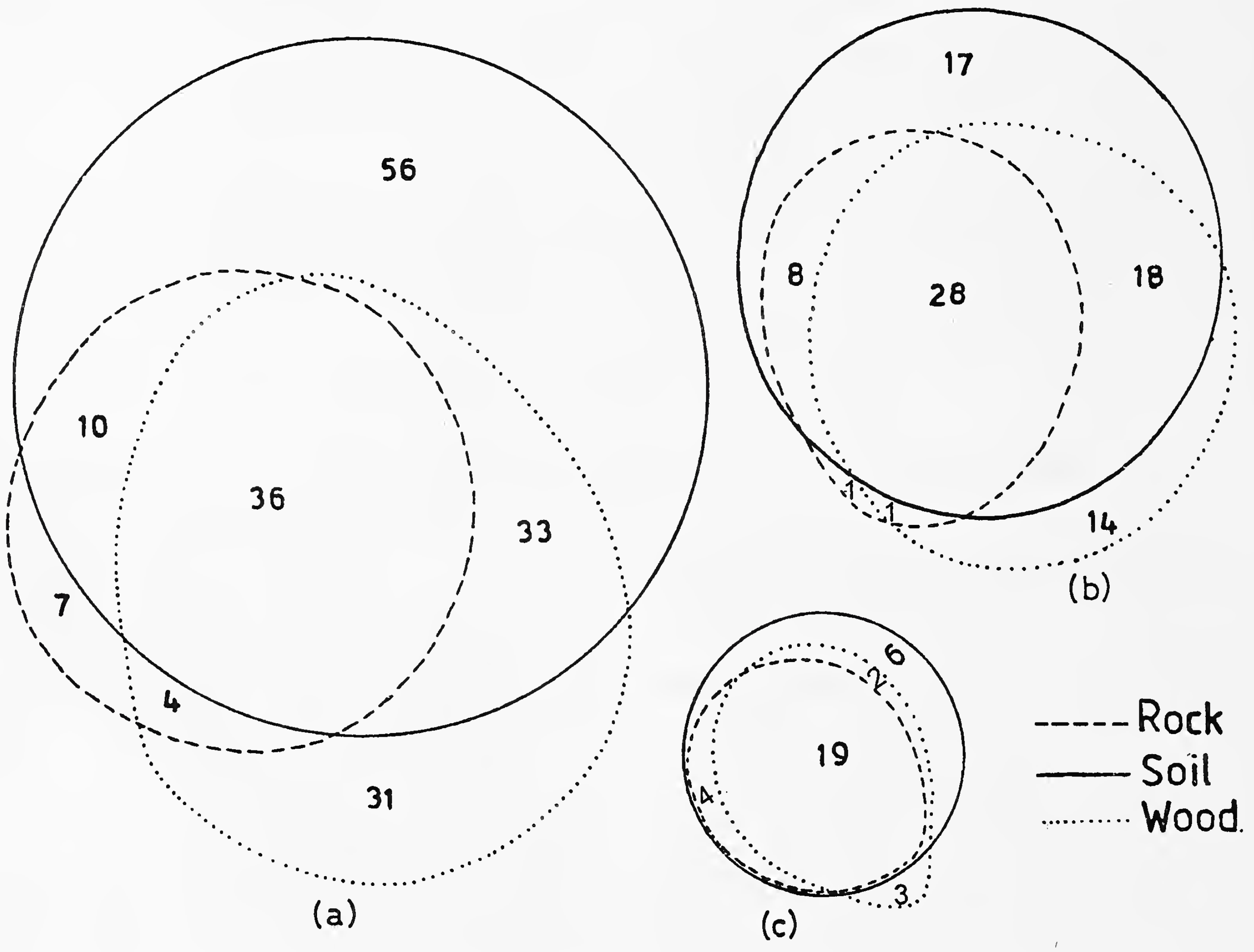

Fig. 2: Venn diagrams depicting distribution of (a) 177 species, (b) 87 genera and (c) 34 families of moss communities on rock, soil and wood

Table 2: Average abundance of mosses [in descending order] per plot and altitude range from Chopta-Tunganath

Family	Taxa Species	Alt. Range Max x100	Min	Fq.	No. of colonies Rock	Soil	Wood	Abun/plot Avg.	Stdev.
Thuidiaceae	*Thuidium cymbifolium* (Doz. et Molk.) Doz. et Molk.	37	25	11	51	595	139	65.42	32.92
Entodontaceae	*Entodon rubicundus* (Mitt.) Jaeg.	37	15	12	26	332	178	44.67	30.32
Grimmiaceae	*Racomitrium subsecundum* (Hook. & Grev.) Mitt.	37	26	10	97	305	11	34.42	40.12
Dicranaceae	*Dicranodontium caespitosum* (Mitt.) Par.	37	25	9	14	353	26	32.75	36.55
Polytrichaceae	*Pogonatum aloides* (Hedw.) P. Beauv.	37	25	11	20	336	8	30.33	22.75
Bryaceae	*Bryum pseudotriquetrum* (Hedw.) Schwaegr.	37	25	8	26	323	5	29.50	47.56
Hypnaceae	*Hypnum cupressiforme* L. ex Hedw.	37	26	10	33	144	84	21.75	17.95
Dicranaceae	*Dicranum spurium* Hedw.	37	34	3	0	220	16	19.67	58.43
Entodontaceae	*Rozea pterogonioides* (Harv.) Jaeg.	36	34	2	26	177	4	17.25	41.96
Hypnaceae	*Ectropothecium cyperoides* (Hook.) Jaeg.	32	25	3	9	138	48	16.25	30.35
Brachytheciaceae	*Rhynchostegium calderii* Vohra	32	25	3	9	138	48	16.25	30.35
Hylocomiaceae	*Hylocomium himalayanum* (Mitt.) Jaeg.	37	26	5	0	153	30	15.25	30.63
Hookeriaceae	*Orontobryum hookeri* (Mitt.) Fleisch	37	25	8	0	129	20	12.42	16.34
Pottiaceae	*Bryoerythrophyllum wallichii* (Mitt.) Chen.	36	26	7	2	120	25	12.25	16.33
Amblystegiaceae	*Amblystegium juratzkanum* Schimp.	32	26	4	3	119	20	11.83	31.25
Pottiaceae	*Oxystegus tenuirostris* (Hook. & Tayl.) A.J.E.Smith	37	15	10	7	115	16	11.50	15.35
Leskeaceae	*Pseudoleskea laevifolia* (Mitt.) Jaeg.	37	26	8	20	87	27	11.17	13.01
Brachytheciaceae	*Rhynchostegiella humillima* (Mitt.) Broth.	37	25	10	6	78	46	10.83	15.20
Leucodontaceae	*Leucodon sciuroides* (Hedw.) Schwaegr.	32	26	6	2	10	116	10.67	19.87
Trachypodaceae	*Trachypodopsis serrulata* (P. Beauv.) Fleisch.	31	15	7	3	40	64	9.08	17.43
Entodontaceae	*Entodon myurus* (Hook.) Hamp.	15	15	1	0	91	16	8.92	30.89
Amblystegiaceae	*Amblystegium serpens* (Hedw.) B.S.G.	37	26	8	1	90	3	7.83	13.90
Polytrichaceae	*Atrichum undulatum* (Hedw.) P.Beauv.	32	25	6	0	85	8	7.75	15.02
Meteoriaceae	*Meteorium buchananii* (Brid.) Broth.	26	25	2	0	0	91	7.58	22.75
Mniaceae	*Mnium rostratum* Schrad.	37	25	7	3	81	2	7.17	18.34
Polytrichaceae	*Pogonatum microstomum* (Schwaegr.) Brid.	37	26	7	0	82	0	7.00	10.01
Brachytheciaceae	*Brachythecium rivulare* B.S.G.	26	25	2	39	35	6	6.67	19.11
Encalyptaceae	*Encalypta streptocarpa* Hedw.	37	34	2	10	68	0	6.50	21.89
Brachytheciaceae	*Brachythecium salebrosum* (WEb. et Mohr) B.S.G.	34	25	8	2	68	5	6.25	10.76
Dicranaceae	*Symblepharis vaginata* (Hook.) Wijk. & Marg.	32	25	6	1	2	72	6.25	13.93
Brachytheciaceae	*Brachythecium kamounense* (Harv.) Jaeg.	32	26	5	0	41	31	6.00	14.60
Dicranaceae	*Atractylocarpus sinensis* (Broth.) Herz.	37	25	4	0	62	2	5.33	8.25
Dicranaceae	*Dicranodontium didictyon* (Mitt.) Jaeg.	34	29	4	5	52	3	5.00	11.14
Orthotrichaceae	*Macromitrium nepalense* (Hook. & Grev.) Schwaegr.	15	15	1	36	5	19	5.00	17.32
Brachytheciaceae	*Brachythecium procumbens* (Mitt.) Jaeg.	34	29	4	7	44	7	4.83	9.32
Neckeraceae	*Homaliodendron sphaerocarpum* Nog.	34	30	3	9	49	0	4.83	15.50
Sematophyllaceae	*Struckia argentata* (Mitt.) C.Muell.	32	26	4	1	5	50	4.67	14.00
Bryaceae	*Bryum badhwari* Ochi	30	25	4	0	48	3	4.25	10.78
Dicranaceae	*Aongstroemia orientalis* Mitt.	37	27	4	2	43	1	3.83	10.03
Bryaceae	*Rhodobryum roseum* (Hedw.) Limpr.	26	15	2	0	46	0	3.83	12.07
Brachytheciaceae	*Eurhynchium striatum* (Hedw.) Schimp.	32	25	3	0	42	2	3.67	6.98
Grimmiaceae	*Racomitrium himalayanum* (Mitt.) Jaeg.	31	29	3	1	34	4	3.25	7.93
Rhytidiaceae	*Rhytidiadelphus triquetrus* (Hedw.) Warnst.	36	34	2	0	37	0	3.08	8.71
Thuidiaceae	*Herpetineuron toccoae* (Sul. et Lesq.) Card.	15	15	1	1	35	0	3.00	10.39
Thuidiaceae	*Thuidium sparsifolium* (Mitt.) Jaeg.	15	15	1	20	0	16	3.00	10.39

Table 2 *(contd.)*: Average abundance of mosses [in descending order] per plot and altitude range from Chopta-Tunganath

Family	Taxa Species	Alt. Range Max x100	Min	Fq.	No. of colonies Rock	Soil	Wood	Abun/plot Avg.	Stdev.
Pottiaceae	*Pseudosymblepharis angustata* (Mitt.) Hilp.	37	26	5	0	3	31	2.92	4.34
Mniaceae	*Mnium pseudopunctatum* Bruch & Schimp.	36	34	2	0	34	0	2.83	8.91
Thuidiaceae	*Anomodon rugelli* (C. Muell.) Keissl.	32	27	5	0	13	20	2.75	4.52
Entodontaceae	*Entodon laetus* (Griff.) Jaeg.	15	15	1	0	33	0	2.75	9.53
Entodontaceae	*Entodon plicatus* C.Muell.	15	15	1	0	33	0	2.75	9.53
Funariaceae	*Entosthodon wallichii* Mitt.	37	25	4	5	27	0	2.67	5.37
Bryaceae	*Pohlia minor* Schleich. ex Schwaegr.	37	26	3	0	29	1	2.50	5.32
Pottiaceae	*Anoectangium thomsonii* Mitt.	31	27	4	4	22	3	2.42	5.23
Amblystegiaceae	*Campylium sommerfeltii* (Myr.) Bryhn	36	34	2	0	29	0	2.42	5.65
Bryaceae	*Pohlia flexuosa* Hook.	29	15	2	0	29	0	2.42	7.76
Hypnaceae	*Vesicularia kurzii* (Lac.) Broth.	37	34	3	0	29	0	2.42	6.60
Pottiaceae	*Hyophila involuta* (Hook.) Jaeg.	15	15	1	25	0	3	2.33	8.08
Brachytheciaceae	*Brachythecium longicuspidatum* (Mitt.) Jaeg.	31	28	3	1	8	18	2.25	6.08
Bryaceae	*Pohlia elongata* Hedw.	32	25	5	0	22	5	2.25	4.69
Brachytheciaceae	*Brachythecium populeum* (Hedw.) B.S.G.	32	32	1	0	24	2	2.17	7.51
Sematophyllaceae	*Brotherella pallida* (Ren. & Card.) Fleisch.	32	32	1	0	24	2	2.17	7.51
Bryaceae	*Anomobryum filiforme* (Dicks) Solms in Rabenh.	37	28	2	0	25	0	2.08	6.91
Hypnaceae	*Vesicularia montagnei* (Bel.) Broth.	34	26	3	7	18	0	2.08	4.52
Brachytheciaceae	*Rhynchostegiella sachensis* Dix.	32	27	2	0	17	7	2.00	6.32
Bryaceae	*Brachymenium ochianum* Gangulee	31	15	8	0	6	17	1.92	2.23
Trachypodaceae	*Duthiella declinata* (Mitt.) Zant.	31	26	4	0	2	21	1.92	5.71
Entodontaceae	*Entodon luteonitens* Ren. & Car.	15	15	1	0	23	0	1.92	6.64
Mniaceae	*Mnium cuspidatum* Hedw.	29	28	2	2	20	1	1.92	5.05
Dicranaceae	*Dicranodontium capillifolium* (Dix.) Tak.	36	29	3	0	20	2	1.83	5.44
Amblystegiaceae	*Drepanocladus uncinatus* (Hedw.) Warnst.	36	36	1	0	21	0	1.75	6.06
Entodontaceae	*Entodon luridus* (Griff.) Jaeg.	30	26	2	5	14	2	1.75	4.94
Hypnaceae	*Vesicularia levieri* Card.	32	26	2	0	15	6	1.75	4.35
Ptychomitriaceae	*Ptychomitrium tortula* (Harv.) Jaeg.	31	29	3	0	20	0	1.67	3.63
Sematophyllaceae	*Brotherella amblystegia* (Mitt.) Broth.	36	36	1	0	19	0	1.58	5.48
Encalyptaceae	*Encalypta ciliata* Hedw.	34	31	2	15	4	0	1.58	4.38
Dicranaceae	*Campylopus involutus* (C.Muell) Jaeg.	37	31	3	0	17	1	1.50	4.58
Bartramiaceae	*Fleischerobryum longicolle* (Hamp.) Loesk.	26	26	1	0	18	0	1.50	5.20
Mniaceae	*Mnium japonicum* Lindb.	37	30	2	0	18	0	1.50	4.60
Thuidiaceae	*Thuidium squarrosulum* Ren. et Card.	15	15	1	17	0	0	1.42	4.91
Dicranaceae	*Campylopus alpigena* Broth.	36	36	1	0	16	0	1.33	4.62
Bryaceae	*Bryum capillare* L. ex Hedw.	31	15	2	8	4	3	1.25	4.03
Dicranaceae	*Dicranum* sp.1	37	31	3	0	11	4	1.25	2.73
Hylocomiaceae	*Leptohymenium tenue* (Hook.) Jaeg.	26	25	2	0	0	15	1.25	3.28
Bryaceae	*Pohlia rigescens* (Mitt.) Broth.	37	36	2	0	15	0	1.25	3.11
Pottiaceae	*Barbula asperifolia* (Mitt.) Crum et al.	31	28	4	0	12	2	1.17	2.62
Fabroniaceae	*Fabronia minuta* Mitt.	15	15	1	14	0	0	1.17	4.04
Hypnaceae	*Isopterygium albescens* (Hook.) Jaeg.	31	30	2	0	5	9	1.17	2.72
Bryaceae	*Pohlia longicolla*	26	26	1	0	12	0	1.00	3.46
Grimmiaceae	*Racomitrium fuscescens* Wils.	29	29	1	0	12	0	1.00	3.46
Entodontaceae	*Entodon curvatus* (Griff.) Jaeg.	29	27	3	1	4	6	0.92	1.78
Bryaceae	*Mielichhoferia mielichhoferi* (Hook.) Wijk & Marg.	31	29	3	0	11	0	0.92	1.98
Rhizogoniaceae	*Rhizogonium spiniforme* (Hedw.) Bruch in Krauss	26	25	2	0	11	0	0.92	2.23
Orthotrichaceae	*Zygodon* sp.1	29	25	4	0	0	11	0.92	1.38

Table 2 *(contd.)*: Average abundance of mosses [in descending order] per plot and altitude range from Chopta-Tunganath

Family	**Taxa** Species	Alt. Range Max x100	Min	Fq.	No. of colonies Rock	Soil	Wood	Abun/plot Avg.	Stdev.
Hypnaceae	*Isopterygium lignicola* (Mitt.) Jaeg.	32	15	3	1	4	5	0.83	2.29
Sematophyllaceae	*Meiothecium speciosa*	29	27	2	0	3	7	0.83	2.12
Thuidiaceae	*Thuidium* sp.1	26	26	1	0	0	10	0.83	2.89
Plagiotheciaceae	*Stereophyllum wightii* (Mitt.) Jaeg.	15	15	1	0	0	9	0.75	2.60
Brachytheciaceae	*Brachythecium plumosum* (Hedw.) B.S.G.	31	29	2	0	8	0	0.67	1.56
Amblystegiaceae	*Campylium chrysophyllum* (Brid.) J. Lauge	37	26	2	0	6	2	0.67	1.78
Ditrichaceae	*Ditrichum darjeelingense* Ren. & Card.	28	27	2	0	8	0	0.67	1.78
Brachytheciaceae	*Brachythecium pachytheceum* (Dix.) Vohra	31	31	1	0	4	3	0.58	2.02
Bryaceae	*Bryum recurvulum* Mitt.	30	30	1	0	7	0	0.58	2.02
Amblystegiaceae	*Hygrohypnum nairii* Vohra	25	25	1	7	0	0	0.58	2.02
Leskeaceae	*Lindbergia longinervis* Card. et Dix.	25	25	1	0	0	7	0.58	2.02
Splachnaceae	*Splachnobryum indicum* Hamp. et Hamp.	37	34	2	2	5	0	0.58	1.73
Dicranaceae	*Campylopus milleri* Ren. et Card.	28	27	2	0	6	0	0.50	1.17
Hylocomiaceae	*Macrothamnium submacrocarpum* (Ren. & Card.) Fleisch.	31	29	3	2	4	0	0.50	0.90
Plagiotheciaceae	*Plagiothecium denticulatum* (Hedw.) B.S.G.	36	29	2	0	6	0	0.50	1.45
Sematophyllaceae	*Pylaisiopsis speciosa* (Mitt.) Broth.	30	29	2	3	3	0	0.50	1.17
Sematophyllaceae	*Sematophyllum micans* (Mitt.) Braithw.	29	27	2	0	4	2	0.50	1.24
Neckeraceae	*Thamnobryum subseriatum* (Hook.) Nog.	31	30	2	0	3	3	0.50	1.45
Sematophyllaceae	*Trolliella euendostoma* Herz.	37	37	1	0	6	0	0.50	1.73
Polytrichaceae	*Atrichum flavisetum* Mitt.	37	32	2	0	5	0	0.42	1.16
Dicranaceae	*Campylopus ericoides* (Griff.) Jaeg.	31	31	1	0	5	0	0.42	1.44
Hypnaceae	*Ectropothecium buitenzorgii* (Bel.) Mont.	29	25	2	0	0	5	0.42	1.16
Hypnaceae	*Isopterygium longitheca* (Mitt.) Jaeg.	31	31	1	0	0	5	0.42	1.44
Pottiaceae	*Barbula constricta* (Mitt.) Saito	31	31	1	0	4	0	0.33	1.15
Pottiaceae	*Bryoerythrophyllum dentatum* (Mitt.) Chen.	28	27	2	1	0	3	0.33	0.89
Bryaceae	*Bryum atrovirens* Brid.	25	25	1	0	0	4	0.33	1.15
Rhytidiaceae	*Gollania clarescens* (Mitt.) Broth.	25	25	1	0	0	4	0.33	1.15
Hylocomiaceae	*Macrothamnium macrocarpum* (Reinw. & Hornseh.) Fleisch.	26	26	1	0	4	0	0.33	1.15
Brachytheciaceae	*Rhynchostegiella divaricatifolia* (Ren. et Card.) Broth.	30	27	2	0	4	0	0.33	0.89
Splachnaceae	*Splachnobryum* sp.1	31	31	1	4	0	0	0.33	1.15
Meteoriaceae	*Aerobryidium filamentosum* (Hook.) Fleisch.	15	15	1	0	0	3	0.25	0.87
Brachytheciaceae	*Brachythecium buchananii* (Hook.) Jaeg.	31	31	1	0	3	0	0.25	0.87
Brachytheciaceae	*Brachythecium curvatulum* (Broth.) Par.	37	29	2	0	3	0	0.25	0.62
Dicranaceae	*Brothera leana* (Sull.) C. Muell.	28	27	2	1	1	1	0.25	0.62
Pottiaceae	*Bryoerythrophyllum recurvum* (Griff.) Saito	37	27	3	0	2	1	0.25	0.45
Bryaceae	*Bryum plumosum* Doz. et Molk.	15	15	1	3	0	0	0.25	0.87
Neckeraceae	*Calyptothecium pinnatum* Nog.	15	15	1	0	0	3	0.25	0.87
Dicranaceae	*Campylopus laetus* (Mitt.) Jaeg.	31	31	1	0	3	0	0.25	0.87
Sematophyllaceae	*Glossadelphus zollingeri* (C.Muell.) Fleisch.	29	26	2	0	0	3	0.25	0.62
Grimmiaceae	*Grimmia redunca* Wils. ex Mitt.	31	31	1	0	3	0	0.25	0.87
Grimmiaceae	*Grimmia* sp.1	31	31	1	0	3	0	0.25	0.87
Hypnaceae	*Isopterygium minutirameum* (C.Muell.) Jaeg.	29	27	2	0	1	2	0.25	0.62
Leskeaceae	*Lindbergia koelzii* Williams	15	15	1	0	0	3	0.25	0.87
Orthotrichaceae	*Macromitrium moorcroftii* (Hook. & Grev.) Schwaegr.	25	25	1	0	0	3	0.25	0.87

Table 2 *(contd.)*: Average abundance of mosses [in descending order] per plot and altitude range from Chopta-Tunganath

Family	Taxa Species	Alt. Range Max x100	Min	Fq.	No. of colonies Rock	Soil	Wood	Abun/plot Avg.	Stdev.
Plagiotheciaceae	*Plagiothecium neckeroideum* B.S.G.	15	15	1	3	0	0	0.25	0.87
Pottiaceae	*Weisia rutilans* (Hedw.) Lindb.	31	31	1	0	3	0	0.25	0.87
Brachytheciaceae	*Brachythecium falcatulum* (Broth.) Par.	31	31	1	0	2	0	0.17	0.58
Brachytheciaceae	*Brachythecium obsoletinerve* Dix.	31	29	2	0	1	1	0.17	0.39
Bryaceae	*Bryum paradoxum* Schwaegr.	28	28	1	0	2	0	0.17	0.58
Hylocomiaceae	*Macrothamnium stigmatophyllum* Fleisch.	37	37	1	0	2	0	0.17	0.58
Mniaceae	*Mnium integrum* Bosch & Lac.	30	15	2	1	1	0	0.17	0.39
Plagiotheciaceae	*Plagiothecium cavifolium* (Brid.) Iwats.	29	28	2	1	0	1	0.17	0.39
Leskeaceae	*Pseudoleskea incurvata* (Hedw.) Loesk.	31	31	1	0	2	0	0.17	0.58
Brachytheciaceae	*Rhynchostegium celebicum* (Lac.) Jaeg.	26	26	1	0	2	0	0.17	0.58
Cryphaeaceae	*Schoenobryum concavifolium* (Griff.) Gangulee	15	15	1	0	0	2	0.17	0.58
Sematophyllaceae	*Sematophyllum subhumile* (C.Muell.) Fleisch.	32	32	1	0	0	2	0.17	0.58
Hypnaceae	*Vesicularia succosa* (Mitt.) Broth.	31	30	2	0	1	1	0.17	0.39
Sematophyllaceae	*Wijkia tanytricha* (Mont.) Crum	30	30	1	0	2	0	0.17	0.58
Thuidiaceae	*Anomodon thraustus* C. Muell.	29	29	1	0	0	1	0.08	0.29
Pottiaceae	*Barbula eroso-denticulata* (C.Muell.) Saito	27	27	1	0	0	1	0.08	0.29
Pottiaceae	*Barbula hastata* (Mitt.) Zander	30	30	1	0	0	1	0.08	0.29
Brachytheciaceae	*Brachythecium brachycladum* (Broth.) Par.	28	28	1	0	1	0	0.08	0.29
Brachytheciaceae	*Brachythecium formosanum* Takaki	30	30	1	0	1	0	0.08	0.29
Brachytheciaceae	*Brachythecium wichurae* (Broth.) Par.	30	30	1	0	0	1	0.08	0.29
Pottiaceae	*Bryoerythrophyllum recurvirostrum* (Hedw.) Chen.	31	31	1	0	1	0	0.08	0.29
Bryaceae	*Bryum caespiticium* L. ex Hedw.	31	31	1	0	1	0	0.08	0.29
Brachytheciaceae	*Cirriphyllum cirrhosum* (Schwaegr.) Grout	30	30	1	0	0	1	0.08	0.29
Fabroniaceae	*Fabronia secunda* Mont.	27	27	1	0	1	0	0.08	0.29
Fissidentaceae	*Fissidens* sp.1	26	26	1	0	0	1	0.08	0.29
Pottiaceae	*Hyophila rosea* Williams	15	15	1	1	0	0	0.08	0.29
Hypnaceae	*Isopterygium* sp.1	29	29	1	0	0	1	0.08	0.29
Orthotrichaceae	*Macromitrium hymenostomum* Mont.	15	15	1	0	0	1	0.08	0.29
Pterobryaceae	*Penzigiella cordata* (Hook.) Fleisch.	31	31	1	0	1	0	0.08	0.29
Bartramiaceae	*Philonotis fontana* (Hedw.) Brid.	31	31	1	0	1	0	0.08	0.29
Bartramiaceae	*Philonotis nitida* Mitt.	29	29	1	0	1	0	0.08	0.29
Polytrichaceae	*Pogonatum neesi* (C.Muell.) Mitt.	30	30	1	0	1	0	0.08	0.29
Brachytheciaceae	*Rhynchostegiella menadensis* (Lac.) Bartr.	31	31	1	0	0	1	0.08	0.29
Cryphaeaceae	*Scopelophila* sp.1	15	15	1	0	0	1	0.08	0.29
Sematophyllaceae	*Sematophyllum caespitosum* (Hedw.) Mitt.	30	30	1	0	0	1	0.08	0.29
Sematophyllaceae	*Sematophyllum humile* (Mitt.) Broth.	30	30	1	0	0	1	0.08	0.29
Sematophyllaceae	*Sematophyllum phoeniceum* (C.Muell.) Fleisch.	29	29	1	0	0	1	0.08	0.29
Splachnaceae	*Tetraplodon mnioides* (Hedw.) B.S.G.	37	37	1	0	1	0	0.08	0.29
Timmiaceae	*Timmia megapolitana* Hedw.	31	31	1	0	1	0	0.08	0.29
Pottiaceae	*Trichostomum bombayense* C.Muell.	30	30	1	0	0	1	0.08	0.29

Alt. = altitude; Max = maximum; Min = minimum; Fq = frequency of occurrence in plots; Abun = abundance
Avg. = average; Stdev. = standard deviation

of the species, 16.09% of the genera and 8.82% of the families were lignicolous (on wood). 3.95% of the species and 1.15% of the genera and none of the families, were saxicolous (on rock). Whereas 55.88% of the families with 20.3% of the species and 32.18% of the genera were

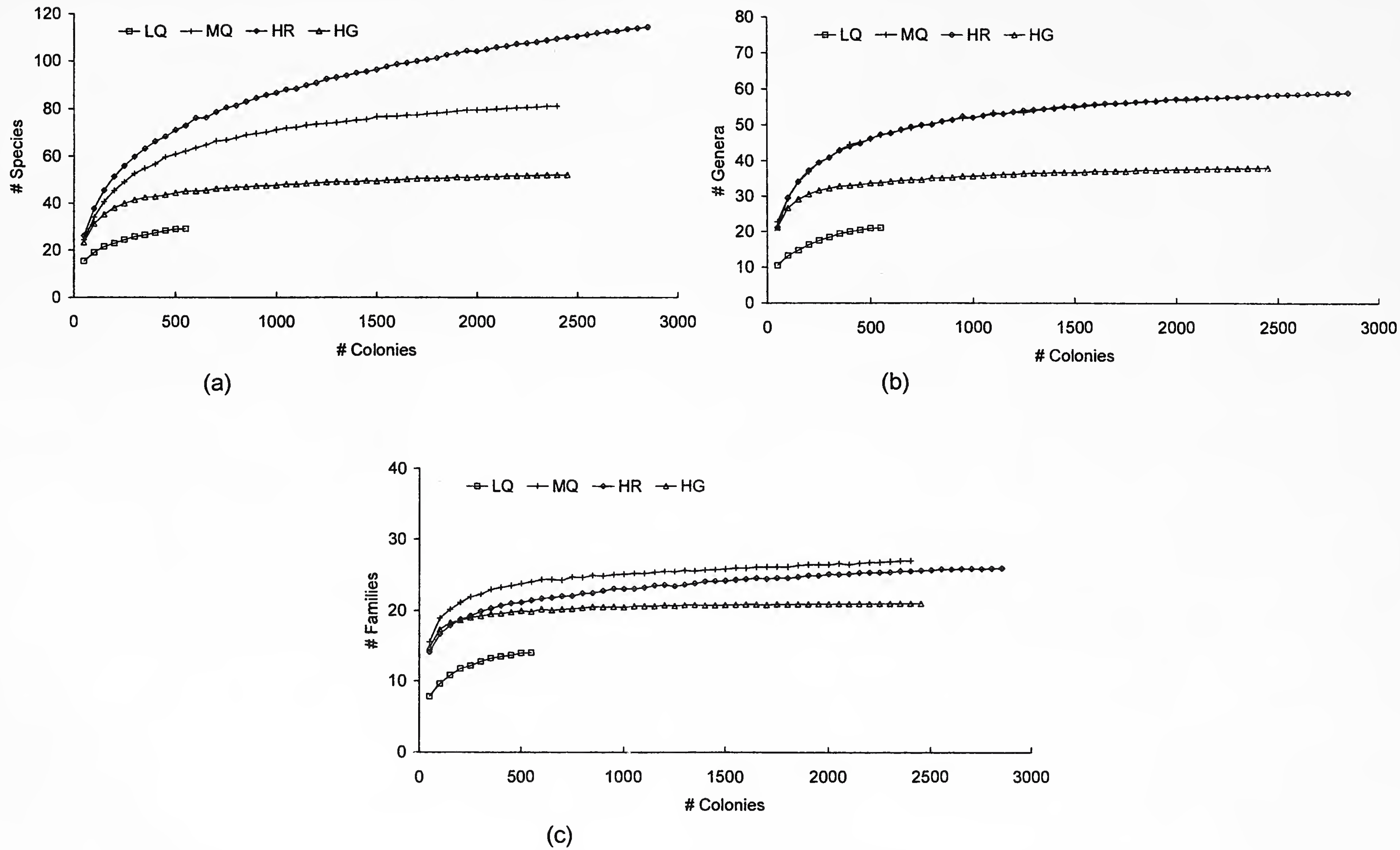

Fig. 3a-c: Accumulation of species (a), genera (b) and families (c) of moss with increasing number of colonies in different macrohabitat types. The macrohabitat types are: LQ; lower altitude *Quercus* forest (1,500 m), MQ; Middle altitude *Quercus* forest (2,500-2,800 m), HR; high altitude *Rhododendron* forest (2,900-3,200 m), HG; higher altitude grassland (3,400-3,700 m). The number of species, genera and families at each interval is an average of 100 simulations

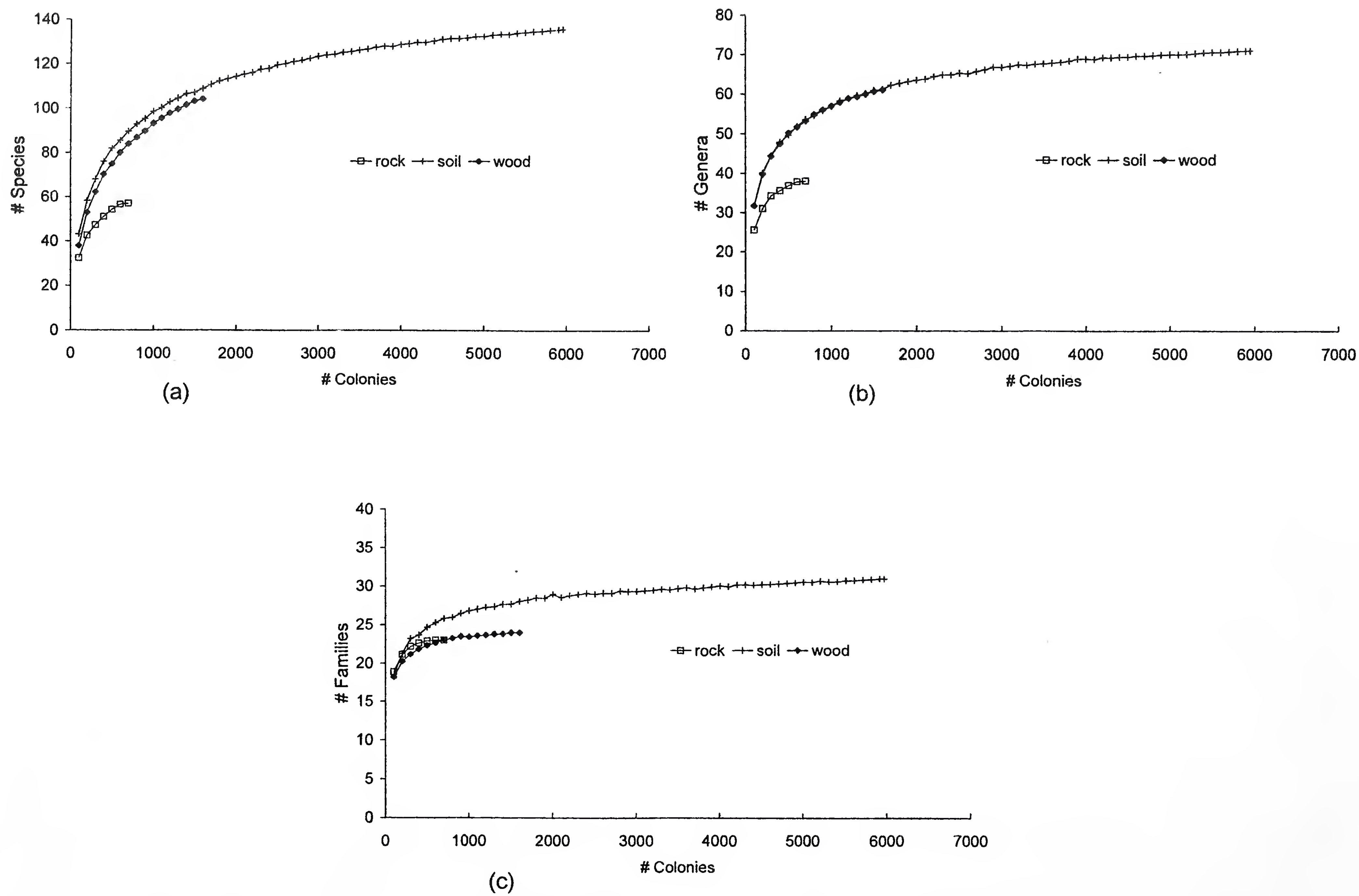

Fig. 4a-c: Accumulation of species (a), genera (b) and families (c) of moss with increasing number of pooled colonies in three microhabitat types namely rock, soil and wood. The number of species, genera and families at each interval is an average of 100 simulations

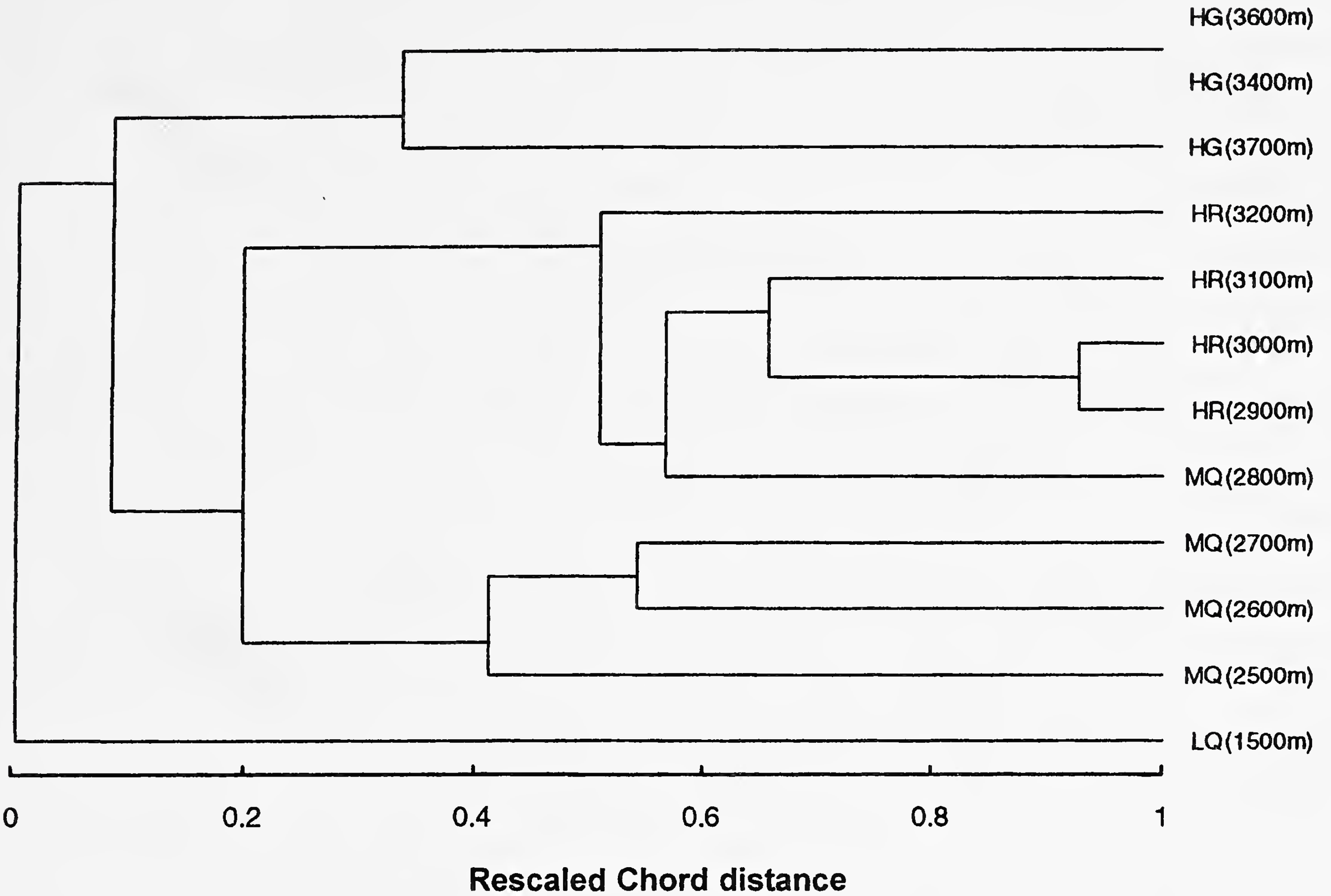

Fig. 5: Complete linkage dendrogram of 12 plots sampled in different macrohabitat types based on Chord distance with respect to species composition. Macrohabitats are LQ: lower altitude *Quercus* forest, MQ: middle altitude *Quercus* forest, HR: high altitude *Rhododendron* forest, HG: higher altitude grassland

generalists, occurring in all three substrates. The rest of the taxa shared two of the three microhabitats in the area.

Entodon rubicundus, *Racomitrium subsecundum* and *Thuidium cymbifolium* were the most abundant, wide-niche generalist species with wide elevation range, frequently occurring in all three substrates. *Philonotis nitida*, *Pogonatum neesi*, *Tetraplodon mnioides* and *Timmia megapolitana*, encountered only once during the study, were rare. Species such as *Pogonatum microstomum*, moderately abundant in more than 58% of the macrohabitat types in the area, may be considered as habitat specialists, confined to soil microhabitats.

High altitude mixed forests of *Rhododendron* have the highest number of moss species, followed by middle altitude *Quercus* forests, higher altitude grasslands and finally lower altitude *Quercus* forest. For family level richness, middle altitude *Quercus* forest is the richest, followed by high altitude mixed *Rhododendron* forest, higher altitude grassland and lower altitude *Quercus* forest. Middle altitude *Quercus* forests and high altitude mixed forest of *Rhododendron* were equally rich in the number of genera in equal numbers of sampled moss colonies (Fig. 3a-c).

Soil microhabitats support the highest number of species, followed by wood and rock substrates (Fig. 4a-c). But at genus level, wood turns up as rich as the soil. The majority of species, genera and families prefer soil and wood microhabitats. However, a few species consistently grow exclusively on rocks. This indicates the importance of rock, soil and wood

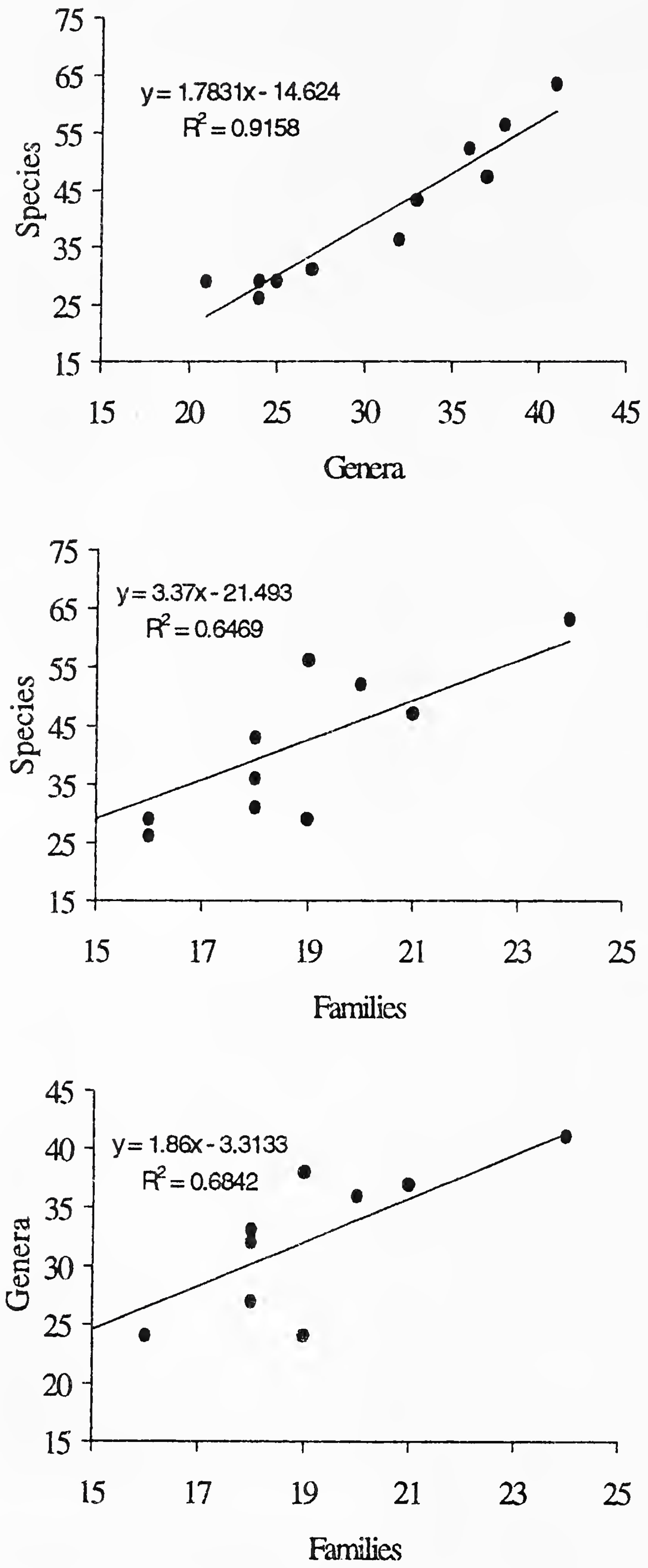

Fig. 6: Relationship between species, genus and family level richness of moss

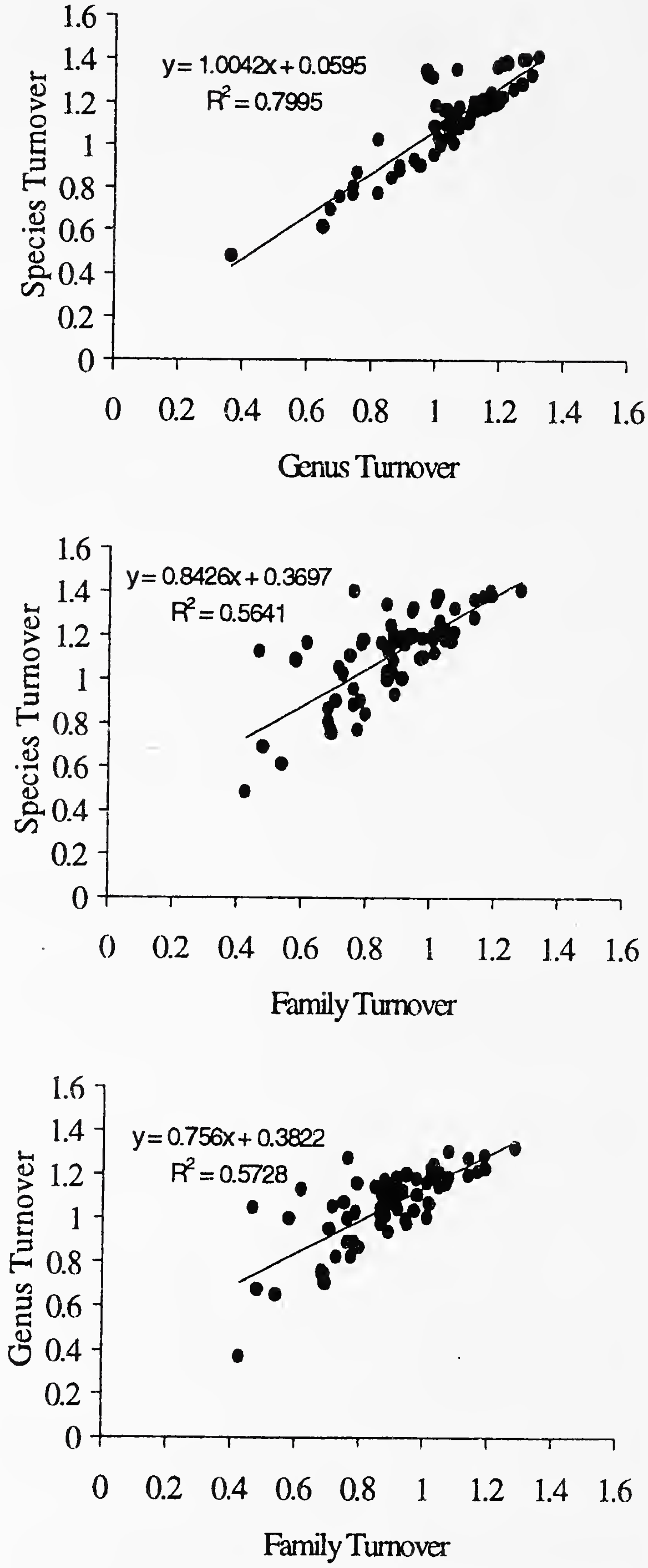

Fig. 7: Relationship between species, genus and family level turnover of moss community

combinations in microhabitats for diversity of moss communities.

The change of composition of moss species across the plots i.e. beta-diversity or turnover along the elevation is depicted in Fig. 5. The plots belonging to the same macrohabitat tend to cluster, depending on the moss species composition. The moss assemblages, therefore, appear to reflect the characteristics of the macrohabitats in which they occur.

The relationships among taxonomic ranks of species, genera and families of mosses with respect to their alpha and beta diversities along with fitted regression equations are given in Figs 6 and 7. There is a significant positive correlation ($p < 0.005$) between species, genus and family level in alpha (Fig. 6) as well as beta-diversity (Fig. 7).

Discussion

Floristic studies in India, particularly on the lower plants, lack objective oriented field methodology. This has hindered the long term monitoring of biological diversity (Negi and Gadgil 1997, Negi 1999, Negi 2000). In this study, replicable methodological approach is adopted that may in turn facilitate comparable studies in future. Numbers of species or any other higher ranks of taxonomic organization at sites (richness or alpha-diversity) and change across the habitats (turnover or beta-diversity) are important parameters of biodiversity in environmental monitoring and conservation evaluation (Magurran 1988, Pressey *et al.* 1994, Negi 1999).

We found that a mosaic of macrohabitats and microhabitats vary in terms of these biodiversity attributes. Higher altitude *Rhododendron* forest is the richest habitat for mosses. Interestingly, the lower altitude *Quercus* forest is consistently poorer than the higher altitude grassland, which hardly has any woody microhabitats for the wood loving taxa. It may be that though the lower altitude *Quercus* forest is managed by the locals for cutting and lopping, there is no control over grazing and collection of fuel wood throughout the year. This probably rendered the forest with only tree trunk bark inhabiting species along with a few saxicolous moss taxa. Higher altitude grasslands are open for grazing, but only during the summer season. Lower diversity of woody plants may also contribute to the paucity of moss in the lower elevation *Quercus* forest. However, there was no significant relationship between numbers of species of woody plants and the moss species diversity in the area. Although the majority of the species were soil specific, the moss richness seemed to be greatly affected by woody microhabitats, as many species occur only on this substrate. This pattern brings out the importance of such microhabitats in the area and cautions us about the potential adverse anthropogenic impacts of deforestation, habitat degradation and fire, the frequency of which is increasing alarmingly in the region (Semwal and Mehta 1996).

The study identifies rare species in the moss community, with quantitative information on the patterns of distribution, populations, taxa in the landscape. Without such information, any program for conservation and sustainable management of bioresources in the fragile ecosystems of the Himalaya will remain on shaky ground.

There is neither time nor funds adequate to sample and identify all the species in a given area for periodically monitoring large diverse lower plant communities such as moss. This is because numbers of species is generally high and the identification is time consuming. Therefore, a reduced set of taxonomic ranks other than the species may be used as surrogates for cost-effective assessment of biodiversity (Williams and Gaston 1994, Prance 1994, Negi 1999). It is therefore necessary to establish a relationship of species diversity with the higher taxonomic ranks. The present investigation attempted to establish such a relationship, and showed that even at the family level, inventory of moss community may be helpful in accurately predicting its species diversity. Similar results have also been shown in the same communities, but from a different landscape in the same region of the Himalaya (Negi 2000).

Conclusions and conservation implications: Moss diversity sharply declines from the seasonally grazed high altitude *Rhododendron* forest and alpine meadows to the highly disturbed *Quercus* forest in the lower elevation. The richness of mosses is related to the moderate levels of

disturbance by grazing and other factors, such as frequency of human visits for fuel wood and fodder collection, which goes on throughout the year in the *Quercus* forests. However, low temperature and high humidity in the high elevation habitats of *Rhododendron* and grasslands might have also contributed to the rich diversity of moss. These factors should be taken care of while designing conservation plans. Apart from livestock grazing, tourism has emerged as the major land use pressure in the high altitude zones of the Chopta-Tunganath. Its increasing demands may lead to overgrazing of higher altitude grasslands and excessive wood collection from the woodlands, leading to severe damage to the moss communities, including the loss of rare species. Thus, the dynamics of biodiversity of moss in relation to the livestock grazing and tourism as major land use activities in the Himalaya needs further research.

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STATUS, ECOLOGY AND BEHAVIOUR OF NARCONDAM HORNBILL (*ACEROS NARCONDAMI*) IN NARCONDAM ISLAND, ANDAMAN AND NICOBAR ISLANDS, INDIA[1]

(*With three text-figures*)

H.S.A. Yahya[2] and Ashfaq Ahmed Zarri[2, 3]

Key words: Narcondam hornbill, *Aceros narcondami*, Andaman and Nicobar Islands, status, behaviour, habitat, feeding, nesting, conservation

Narcondam Island is part of the submerged lines of hills which constitute the Andaman and Nicobar (A & N hereafter) Archipelago in the Bay of Bengal (Abdulali 1971). The Narcondam hornbill *Aceros narcondami*, endemic to Narcondam Island, is an interesting species from the ecological and evolutionary point of view, and is also a Red Data Book (RDB) species (King 1981). It has been declared endangered due to its restricted range (Stattersfield *et al.* 1998). The Island was recently declared an Important Bird Area (IBA) under the IBA programme launched by Birdlife International and the BNHS in India. Considering the isolation of this important species and scanty information on its ecology and biology, a short-term study was conducted in March 2000. Line transect method was adopted for population estimation. Observations were carried out to collect data on behavioural aspects like feeding, pre- and post-roosting behaviour, nesting, vocalization and interaction with other species. Circular Plot and PCQ method were used to estimate the tree density. Around 432 birds were estimated to be on the Island. Population density estimate using line transect was 72 birds/sq. km. Twenty active nests were recorded. Though the present population seems to be stable, the confinement of the hornbills on such a small island makes them vulnerable to intrinsic and extrinsic threats.

Introduction

Island life exhibits features of special interest. The sea is a barrier to its colonisation by terrestrial life forms, but the species that are once established frequently develop new features in their isolated surroundings. A long established sea barrier results in marked differences between the animal and vegetation even of adjacent islands. India has a number of islands both in the Bay of Bengal and Arabian Sea, the former being much larger and more habitable. The islands in Bay of Bengal represent submarine mountains, while the islands in the Arabian Sea are entirely built by corals (Singh 1920).

The Narcondam hornbill (*Aceros narcondami*) is an endemic bird. Scanty information is available on its population, ecology and biology, due to the remoteness of its home, Narcondam Island. There are records of only seven to eight visits, of not more than five days, between 1873 and 1984. Prain (1893), Cory (1902), Osmaston (1905) and John (1889) are few records of the species. Hussain (1984) and Ravi Sankaran (pers. comm.) in 1998 spent 1-3 months. Kemp (1995) has summarized information and Ravi Sankaran (pers. comm.) has discussed the current conservation problems of this vulnerable species. A rough estimate given by Ravi Sankaran indicated 290-320 birds. Apart from these, there is no other comprehensive study on the biology and ecology of the Narcondam hornbills. Thus, the present study was conducted to assess the present status, ecology and behaviour of this isolated species.

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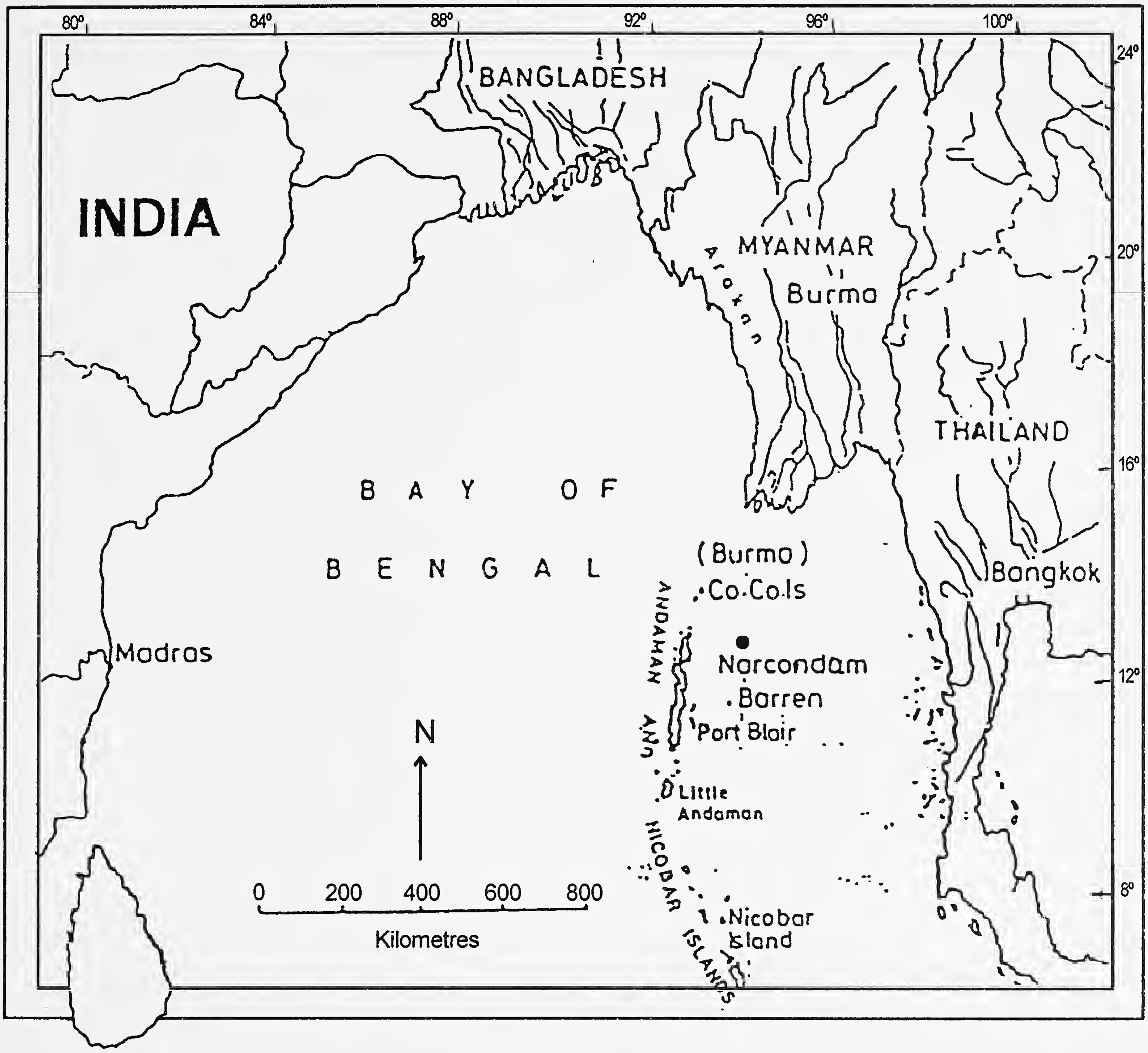

Fig. 1: Location Map of Narcondam Island

Hornbills (Bucerotidae and Bucorvidae) are a group of large, forest and savanna birds restricted to the Old World tropics. There are 54 species of hornbills in the world (Kemp 1988), nine of which occur in India (Ali and Ripley 1970). Only in the last decade, some studies provided valuable insight into the ecology of these unique cavity-nesting birds (Mudappa 2000). The Indian hornbills are secondary cavity-nesters, largely forest dwelling species and predominantly frugivorous (Kemp 1976).

Study Area

Narcondam Island is one of the 323 islands of the Andaman and Nicobar Islands, which lie in a long and narrow broken chain, approximately north to south, sprawling like an arc, and having an area of 8,293 sq. km. Around 80% land area is under forest cover. Narcondam Island (13° 27' N, 94° 17' E) lies about 114 km off Port Blair towards Myanmar (Fig. 1). It lies about 500 km off the Mergui Archipelago and about 300 km southwest of the Gulf of Martaban

in Myanmar (Kemp 1995). It is logical to presume a former connection from Cape Negris at the southern end of Burma to Achin Head (Cape Pedro) in Andalas (Sumatras) (Osmaston 1905)

The Island is an outcome of volcanic actions from the Sunda group, and lies, with the Nicobars, along one of the principal lines of weakness in the earth's surface. Wadia referred to it as a craterless volcano composed wholly of andesectic lava (Abdulali 1971). The total area is approximately 6.8 sq. km, and the highest peak is about 750 m above msl.

Legal status

The Island was recently declared a Wildlife Sanctuary under the Wildlife (Protection) Act 1972. It falls under the jurisdiction of the DFO, Mayabunder in the North Andaman. It was uninhabited until 1969, when the Government of India made a lookout post. A party of 17 police personnel is deputed on the Island for three months by rotation. A lighthouse has recently been constructed on the southern edge of the Island.

Climate

The climate of the Andamans group of Islands is tropical wet and humid, with daily temperature ranging from 27.8 °C maximum to 21.8 °C minimum. The Island receives both southwest and northeast monsoons, from May to October. At times, cyclonic storms occur during this period, with rough weather conditions almost throughout the season. The average annual rainfall recorded for the Island from the nearest weather station at Mayabunder is 3,055 mm, with an average of 134 rainy days/year. July records the highest and March the lowest rainfall.

Vegetation

Prain (1893) described some aspects of the flora of Narcondam (Hussain 1984). The flora of the Andaman and Nicobar group of Islands has been described in detail by Parkinson (1923) and Thothari (1960). The Island bears several generations of old, dead and decaying trees, interlaced with thorny creepers and luxuriantly flowering tall trees. The vegetation can be divided into littoral, deciduous, evergreen and moist evergreen.

The flora on the highest zones of the hill are mostly evergreen trees such as *Dipterocarpus*, *Sideroxylon* and *Ficus*. However, some deciduous species (e.g. Semul *Bombax insigne*) are also seen. The vegetation towards the summit is mostly moist evergreen with several epiphytes. The lower hills following the shoreline have both deciduous and evergreen trees like *Terminalia catappa*, *T. bialata*, *Parishia insignis*, *Caryota mitis* and several thorny creepers.

The shoreline has some introduced species such as coconut and banana. Apart from the introduced species, we could identify *Sterculia religiosa*, *Barringtonia speciosa*, *Thespesia populnea*, *Pandanus*, *Scaevola koenigii*, *Ipomea biloba* and *Hibiscus tiliaceus*. Good timber species also occur on the Island.

Campsite and its environs

The police camp area is very picturesque and is located on the eastern side of the Island. A considerable area has been transformed into a kitchen garden, with introduced plants, including about 25 varieties of vegetables and fruits. Some of the introduced species are growing like weeds. Remarkable among them is Tulsi (*Ocimum* sp.), which can be seen in thick patches almost on all sides of the camp. It has also started invading the upper areas of the forest. Several trees of *Ficus*, *Terminalia catappa* and a small mangrove patch were also seen.

Methodology and Analysis

The Line Transect Method (Emlen 1971) was adopted to estimate the density of Narcondam hornbills. The computer program

TRANSECT was used to analyze the data. The program calculates density of objects at three cut points and generates 95% confidence interval for each estimate (Burnham *et al.* 1980). We also calculated the density manually by the following formula

$D = n / 2LY$

where D = Density, n = No. of sightings, L = Total length walked and Y = Average perpendicular distance

Feeding at the nest by males was studied by shifts of observations on three nests, and three complete days were spent on each nest. Food items were identified by direct observation of fruiting trees and indirectly from the debris collected from the base of the nesting trees. Seeds collected from the midden were catalogued.

Density of fruiting and nesting trees was estimated by taking 10 m circular plots. The general tree density of the study area was assessed by the Plot Circular Quadrat Method (PCQ). Plants of height greater than 5 m were considered for this purpose. A herbarium of tree species was collected and identified with the help of scientists at the Botanical Survey of India, Port Blair.

Active nests were located by following the breeding males, and by checking signs of the previous year's fecal remains (midden) at the base of nest trees. At times, begging calls of the young hornbills being fed by the males also helped in locating active nests. A wooden boat was used for observations along the periphery of the Island. A hide was constructed at Nest No. 2 for regular observations and photography.

RESULTS

Population, status and distribution

The density of the hornbills was calculated as 72 birds per sq. km. Considering the effective hornbill habitat (6 sq. km), about 432 birds occur on the Island. However, a density of 83 hornbills per sq. km was estimated by the Fourier Series Estimator; percentage coefficient of variation was 8.9, lower limit 75.53 and upper limit 87.95.

The hornbills are almost uniformly distributed on the Island, with no preference for any landscape feature. Fig. 2 shows the number of sightings in each group of perpendicular distances. Most of the encounters were between 10-30 m of perpendicular distance.

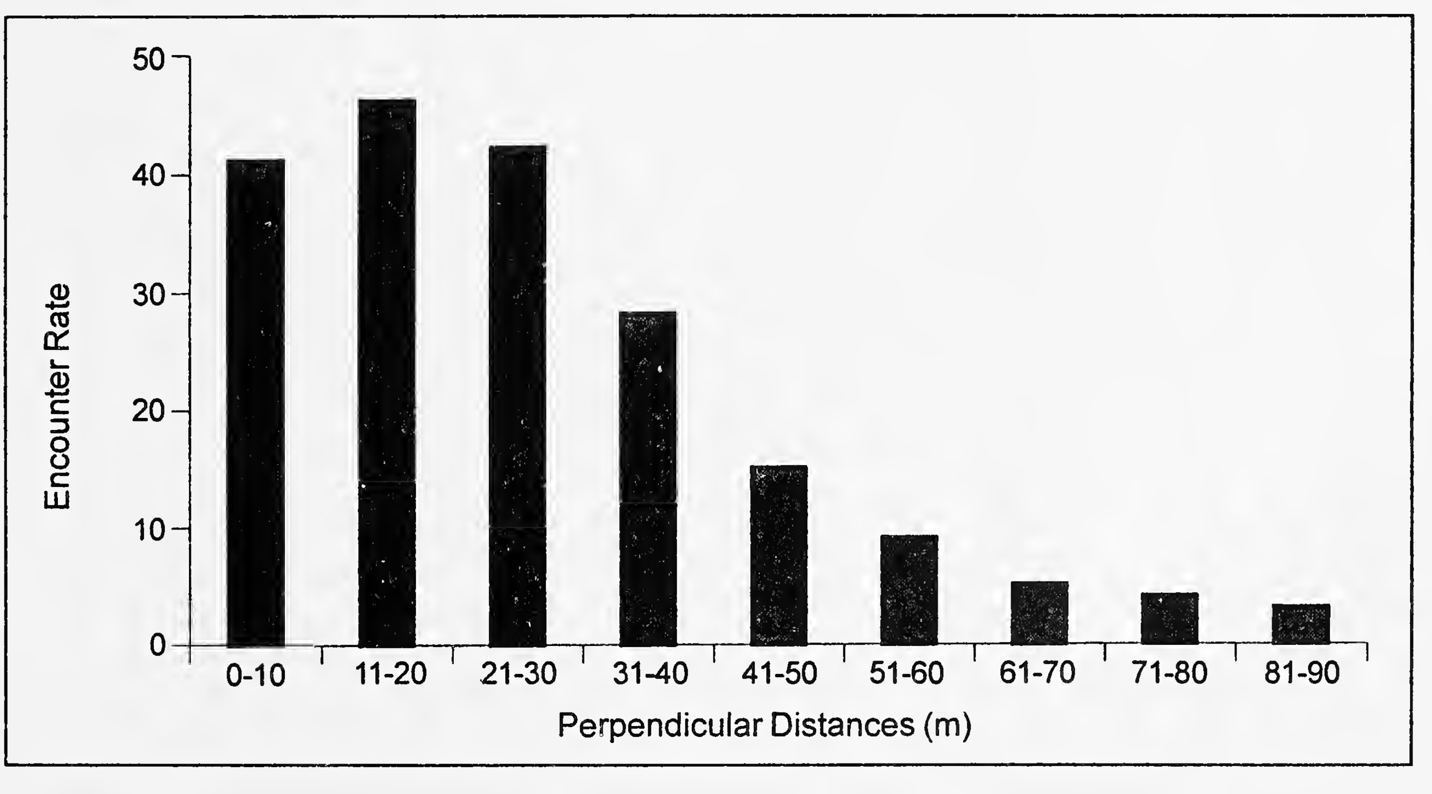

Fig. 2: Number of sightings in each group of perpendicular distances

Nest site characteristics and distribution

There is no apparent preference for a particular tree species for nesting (Table 1). Nests were recorded on slopes, in valleys and on ridge tops at different altitudes. Nests were predominantly found in trunks of living trees, some were also seen in partially dead tall trees. Nest height varied from a minimum of 3 to 35 m in the recorded nests, however, most of them were 10-20 m high (Table 1). One unusual nest was recorded in the main trunk of a very thin tree about 5 m above the ground.

The shortest distance between two nests was 8 m. Other bird species also nested near the hornbill's nest: one nest of Alexandrine parakeet (*Psittacula eupatria)* was just one metre above the hornbill's nest on the same tree, while another nest of the olive-backed sunbird (*Nectarinia jugularis*) was 4 m away.

Most hornbill nests were found facing east or west. Nest cavities of hornbills are probably used year after year, as evidenced by the remains of an old *machan* (Platform) near Nest No. 2, which was used by Sankaran in 1998. Nests were almost uniformly distributed on the Island, irrespective of altitude or other difference in microhabitats and there was no clumped setting. We found nests even just below the summit of the Island (645 m above msl, Table 1).

Tree density

A total of 9,420 sq. m area was sampled to estimate the fruiting and nesting tree density. 102 fruiting trees were recorded in sampled plots, giving a total density of 1,080 individuals per sq. km. Only 21 nesting trees were recorded in the same area and their density was calculated to be 222 trees per sq. km. However, the general tree density was 5,160 trees per sq. km from a sample of 50 circular plots.

Behavioural observations

Nest feeding: The incarcerated adult female and nestlings are dependent on the male for providing food. A narrow slit was left in the wall through which the male fed his mate throughout the incubation and nestling period. The male offered berries, regurgitated one by one

Table 1: Details of Narcondam hornbill nests recorded during March 2000

Nest	Date	Altitude (m)	Tree (Local name)	Slope Face	Nest opening	Nest Height (m)	App. Tree Height (m)
1	10.03	105	Thipok	East	East	12	30
2	11.03	120	Lattoo	West	South-west	15	28
3	13.03	95	Thipok	West	North-west	30	39
4	13.03	80	Thipok	West	South-west	10	28
5	15.03	490	Thipok	West	North-west	17	28
6	17.03	55	?	East	South-west	12	28
7	17.03	55	Thipok	West	West	35	39
8	19.03	35	?	West	Vertically upward	30	41
9	19.03	125	Dhoop	East	North	13	30
10	20.03	90	Mahua	South-east	South	20	32
11	21.03	645	Jaiphal	South-west	South-west	18	30
12	23.03	255	Jaiphal	East	North	5	25
13	23.03	245	Mahua	South-east	South-east	14	18
14	24.03	95	Dhoop	South-west	East	18	30
15	24.03	110	Mahua	North-west	West	28	34
16	25.03	160	Kali Lakri	East	West	10	27
17	25.03	190	Kali Lakri	South	North	11	27
18	26.03	80	Thipok	North-west	South	13	28
19	26.03	98	Lattoo	South-west	South-west	25	29
20	26.03	110	Lattoo	South	South	20	29

and shifted up to his bill-tip, to the female who passed it on to the young. Older nestlings may receive food directly from the male, but this was not clearly visible.

The Narcondam hornbill is mainly frugivorous like other hornbill species and has a regular daily feeding schedule. Nest feeding started at 0440 hrs and the last feeding was recorded at 1705 hrs. Fig. 3 shows the average number of feeding visits made by the male on Nest Nos. 1, 2 and 3. On an average, the male made 2.5 visits per hour. No feeding was observed during heavy rain, as the wet male had to cling strenuously on to the nest to feed the nestling and female. Invariably maximum feeding was done during morning hours (Fig. 3).

Food of the hornbill mostly constitutes of large drupes, wild fig, and berries; also insects, lizards and small animals. Nine species of fruits were identified: *Caryota mitis*, *Mystica andamanica*, *Artocarpus chaplasha*, *Delinea indica*, *Sideroxylon longipetiolatum*, *Ficus scandens*, *F. glomerata*, an unidentified *Ficus* species and *Syzigium cuminii*.

Number of insertions per visit by the male varied with the size of the fruit, 2-77 insertions were recorded on Nest No. 1. However, mean numbers of insertions was $x = 23.5 \pm 18.7$, $n = 32$. Similarly, on Nest No. 2, 1-40 insertions per visit were recorded, while mean number of fruits fed was $x = 15.4 \pm 11.6$, $n = 32$.

Total time spent by the males on Nest No. 1 ranged between 1 and 11 minutes. However, the mean time spent per visit was $x = 15.4 \pm 4.37$, $n = 32$. Similarly, the range of total time spent on Nest No. 2 was from 0.5 to 7 min, while mean time spent was $x = 2.81 \pm 1.6$, $n = 32$. Once the feeding was over, the male would clean its beak on the branch a few times, and often preen for a while before flying away.

Interactions with other species: On three occasions, we observed 4-5 hornbills mobbing the white-bellied sea-eagle *Haliaeetus leucogaster* and chasing it from tree to tree. No apparent inter- or intra-specific competition for nesting sites was recorded. Alexandrine

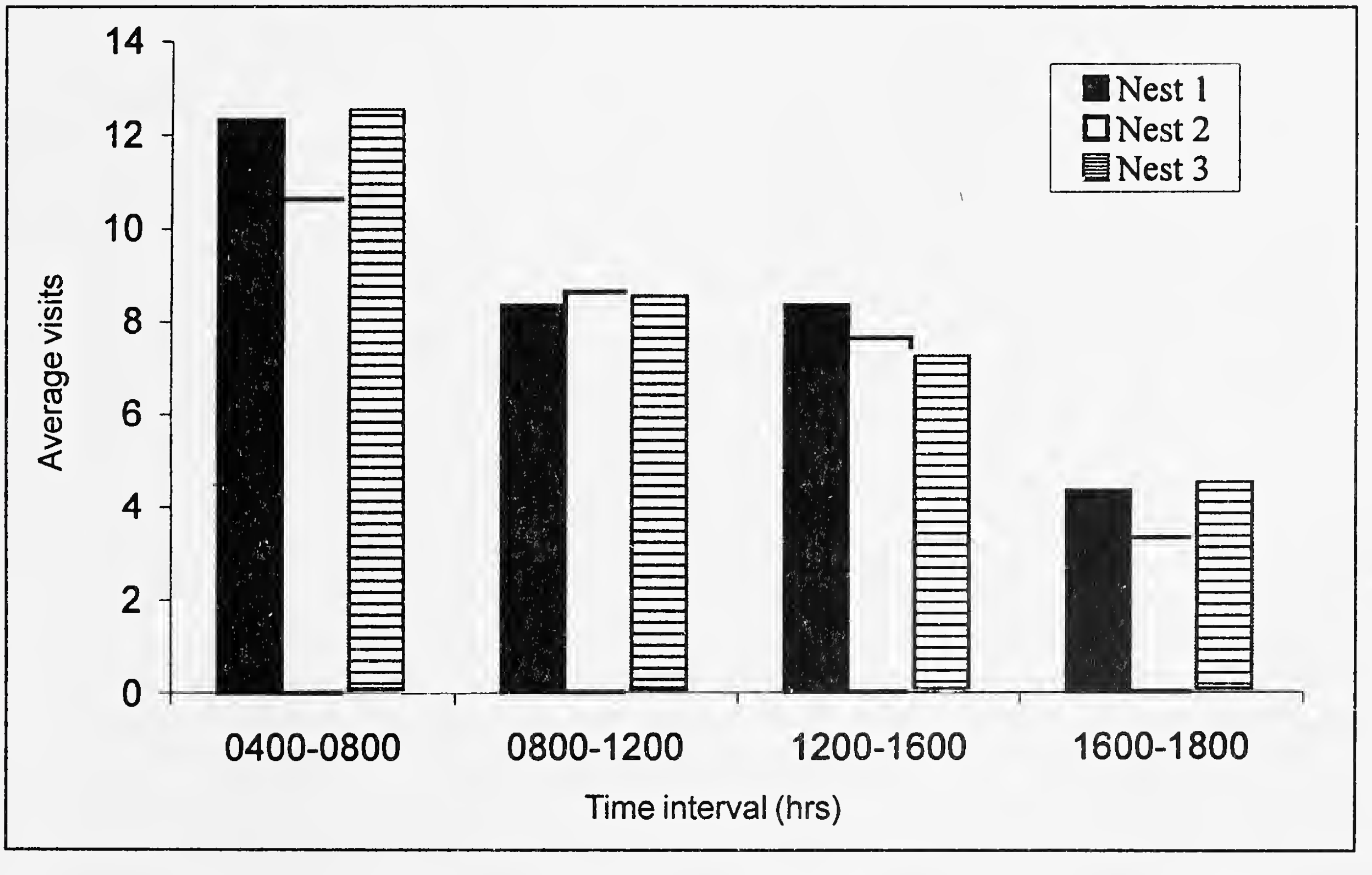

Fig. 3: Feeding visits of male Narcondam hornbill in nest during different time of the day (n=3 days/nest)

parakeets and common hill-myna (*Gracula religiosa*) were recorded nesting on the same tree as the hornbills. We did not notice any predators. Once a hawk (unidentified species) was observed soaring in the sky. However, considering its small size, it did not appear to pose any threat to the hornbills.

Feeding in group: While breeding pairs were recorded feeding and collecting foods largely individually or in groups of 2-3 birds, large flocks up to 50 non-breeding birds were regularly noted feeding, displaying or flying together up and down the valley. The composition of such feeding flocks is given in Table 2. They were recorded almost throughout the day, but were larger, more noisy and active during late afternoons while preparing to roost.

Fighting, chasing, billing, calling and preening were the common activities during feeding and foraging. At times, two or more in the group would fly up in the air, move in the group, move zigzag up to about 100 m and then descend. Similar acrobatics were performed during pre-roosting and post-roosting activities. While feeding in groups on the fruiting trees at times, some were seen descending on the bush and even catching insects, often as low as 1 m above the ground. However, the breeding males were recorded searching for insects more than the non-breeding birds. Larger congregations on fruit-laden trees (mainly *Ficus* spp.) were observed almost every evening before roosting. Congregations of 4-5 breeding males were also observed occasionally, at times other than

Table 2: Activity and flock composition of Narcondam hornbill during March 2000

S.N.	Time of observation			Total	Male	Female	Activity
	Start	End	Total (min)				
1	1650	1726	36	32	19	13	Calling, preening, hoping
2	0510	0543	33	15	08	07	Feeding & displays
3	1200	-	-	04	02	02	Flight
4	1437	1500	23	14	05	09	Actively feeding
5	1645	1705	20	50	24	26	Pre-roosting displays
6	1103	1121	18	04	03	01	Feeding actively
7	0600	0645	45	06	05	01	Feeding & aerial displays
8	0725	0728	03	04	02	02	Aerial displays
9	1517	1529	12	05	02	03	Active calling & feeding
10	0940	0945	05	04	-	-	Flight
11	1610	1700	50	37	19	18	Pre-roosting activities
12	1615	1633	08	05	02	03	-do-
13	1530	1610	40	06	-	-	Acrobatics & Feeding
14	1530	1700	90	22	14	08	-do-
15	1612	1620	08	05	03	02	Mobbing white-bellied sea-eagle
16	0615	0620	05	07	-	-	-do-
17	1215	1230	15	19	-	-	Aerial movements
18	1515	1542	37	19	10	09	Feeding & Acrobatics
19	0542	0724	96	18	-	-	-do-
20	0905	0910	10	06	-	-	Flight
21	1150	1203	13	11	05	06	Active feeding
22	0545	0630	45	48	22	26	Feeding & Acrobatics
23	1340	1445	65	16	09	07	Feeding & Calling
24	0900	0910	10	18	-	-	Feeding & Resting
25	1600	1630	30	34	20	14	Pre-roosting activities
26	1500	1620	80	22	12	10	Pre-roosting activities
27	0555	0558	03	04	02	02	Acrobatics

feeding. On two such occasions, the males were recorded mobbing and chasing white-bellied sea-eagles from their nests.

Pre-roosting Behaviour: The roosting pattern in the Narcondam hornbill appears to be "generally bird-like", settling in the evening at the approach of dark, and emerging early in the morning. They roost in the foliage of the tree, in groups, at a particular site. Pre-roosting activities of non-breeding flock were recorded every day. During this study, a flock of about 50 birds (mainly non-breeding) was followed for 20 days, one hour before settling time and one and a half hours after they emerged from the roost.

Pre-roosting activity of the non-breeding flock consists of loud calls, chase of members and acrobatics. Such flocks comprised of several males and females, all moving in a semi-circular direction, from branch to branch and tree to tree, at times alighting on low bushes. Feeding during this period was noted to be very brief. At times, they perched on foliage one on each top branch, calling and preening alternately. The number of birds in such flocks varied from 4 to 50 on different days (Table 2). Pre-roosting activities start around 1600 hrs and lasted up to sunset. At dusk, all birds would become quiet and leave the foraging area in groups of 2, 3 or 4, all following the same route southwest of the camp.

The most interesting pre-roosting behaviour was the performance of acrobatics in which one bird would fly high up in the sky and then drop down haphazardly and zigzag. These performances were reminiscent of the displays of pigeons and doves, but while these select particular branches to initiate the display and return to almost the same perch, the Narcondam hornbill acrobatics were less organized. The pre-roosting activities of the breeding pairs were not very pronounced. While the females remained inside the nest holes, the males kept feeding them and the young until quite dark and then after the last feeding moved to a nearby thick foliage.

Post-roosting activities: Post-roosting activities were less pronounced in the hornbills. After emerging one by one from the roost, the birds rushed to nearby trees and started feeding in small flocks. However, on overcast mornings or after moderate rains the birds were noted performing prolonged aerial dynamics as recorded in the afternoons. During cloudy and drizzle mornings, play behaviour of males and females on fruiting trees was recorded to be more elaborate. The first feeding in the morning lasted about 15-20 minutes and then suddenly the whole group would move in other directions one by one.

The breeding males were observed to collect food immediately after emerging from their roost and rushing to their nest. The first feeding was recorded as early as 0440 hrs. No siesta was recorded during day hours. However, some birds especially the breeding males were recorded resting on exposed branches, preening and calling at times between two nest feedings in the hotter hours of the day.

Calls and Vocalization: The call of the hornbill is a trisyllabic "*qua qua qua*". While hopping and feeding on the fruit trees, it calls "*quank quank*" repeating about 100 calls/minute. Similar calls were noted in non-breeding males during display. At times, calling symphony of two hornbills was observed. Two males perched on nearby trees called up to 5 minutes at a stretch, responding '*qua*' to each other. Since these calls were heard near nesting trees, they could be territorial calls. Flock of non-breeding young hornbills, called loudly during pre- and post-roosting activities.

The hornbill was noted to be the most vociferous bird on the Island, invariably uttering loud shrill calls at all occasions. Most of these calls were found to be associated with maintaining the flock together. Territorial calls by breeding males were quite pronounced, and very helpful in locating their whereabouts and nests. While carrying food to the nest, the male starts calling from about 100-150 m away from the nest, until it arrives to the nesting trees.

Females incubating / brooding inside the nest often responded to these calls with less noisy croaking. When disturbed, a fast and repetitive series of trumpeting sounds is uttered. These calls were faint "*qua qua*" in low tempo, audible up to about 50 m from the nest. These calls were made in response to calls of males or to induce him to bring more food.

Once a hornbill and a koel were observed calling in competition with each other. The hornbill called "*qua qua qua*" three times, while the koel responded with three "*ki ki kik*" almost simultaneously and continued doing so for about 1.5 minutes. In flight, adult birds continuously call '*ka .. ka .. ka*'. The female inside the nest is generally silent, but some times utters a single '*krwak*' if the male is late in offering the next berry. The male, when alarmed, calls a halting '*ko .. kokokoko ..ko ..kok .. ko*', while the female, when alarmed, emits repeated '*ktaawk kok kok*' similar to the alarm calls of the domestic fowl (Hussain 1984). Males do not react to human disturbance close to the nesting tree.

Food begging calls of the chicks: Begging calls for food was often heard near the nests. The male brings food near the nest, calling loudly until it finally perches on the outer rim of the nest. The chicks keep calling '*chew . . . chew . . . chew*', continuously, like a sewing machine in operation, until they are fed.

At times the chick can be heard calling, even when the male is away. Although spotting a nest in the presence of the highly vocal male is easier, chick calls facilitate the process. We located three nests by hearing such chick calls. The chicks also make soft *kee kee kee* ... calls on the approach of the male with food.

Discussion

In the past 400 years, 93% of the species and subspecies of birds that have become extinct have been island forms (King 1981). Most of these were due to loss of habitat, smaller population size, competition, predation, disease or other catastrophes. Population regulation factors become crucial for endemic species like the Narcondam hornbill, since the Island size is very small. Competition for nesting cavities and food may also affect the hornbill population on the Island. During our study, five different hole nesting species of birds were recorded breeding.

No predator of the hornbill has been recorded so far on the Island. Water monitor, the only large reptile on the Island is known for its egg stealing habits (Daniel 1983), and thus may be possible predators. Hussain (1984) reported a flying snake just near the hornbill nest. Mobbing of koel and white-bellied sea-eagle by the hornbill has also been reported earlier.

The avifauna of Narcondam is not very rich compared to any other moist deciduous and tropical forest. The most obvious limiting factor is the oceanic barrier and the Island's remoteness. The nearest island is the North Andaman. The Coco Island of Myanmar is about 96 km, while the contiguous forested islands of Diglipur and Mayabundar (North and Middle Andaman) are also quite far. Bird life even in these forests is sparse.

From the density figures obtained, the Narcondam hornbill is surely not facing any danger of extinction, but is vulnerable due to confinement and isolation. The population seems to be stable at present. However, their status and population should be constantly monitored and disturbance to the Island should be minimized.

The nest site selection by the hornbills may depend on characteristics of nest cavity and of the surrounding habitats (Klop *et al.* 2000). Natural cavities are used by most species although some smaller species may use old barbet or woodpecker holes (Kemp 1976). Once a suitable hole is selected, the entrance is plastered with sticky materials (e.g. mud, feces, wood shavings, saliva, fruit pulp, etc.) until no more than a narrow slit is left open.

During our study we found no particular preference in nest cavity selection, but more nests were seen on east and west facing slopes, depending mainly on the availability of the cavities. However, Muddapa (2000) has reported preference for northeast aspect in case of Malabar grey hornbill (*Ocyceros griseus*). The nest site selection in general may depend on other factors like height of nest, cover, surrounding habitat, slopes, nearness of fruiting trees and disturbance factors. Nests facing east or west may get more sun light, which would be helpful in keeping the nest hygienic and the female/nestlings healthy.

Nests of the hornbill were recorded wide apart and in different areas from shore to the summit. Such a nesting pattern has been described as anti-predatory strategy between neighbours (Klop *et al.* 2000). The kind of spacing, although, is the result of several intrinsic and extrinsic factors.

Tree density

From the results, the density of nesting and fruiting trees looks quite favorable for the present population of hornbills. The occurrence of such a high tree density is feature of the tropical moist forest ecosystem. Thus, the habitat is highly suitable for species like the hornbills, which require adequate nesting cavities in every breeding season.

Breeding cycle

The breeding cycle of the Narcondam hornbill is synchronous with food productivity of forest (i.e., fruiting phenology). Like most other bird species, hornbills are mainly fruigivorus. They exhibit wide-ranging movements to meet their specialized food requirements (Poonswad 1995). Functionally, they have been described as keystone naturalists (Gilbert 1980) as they play an important role in the dispersal of many rare rainforest tree species (Kinnard 1998, Whitney e*t al.* 1998).

Food

We identified nine species of fruits being fed by the male during this study, while Kannan and James (1997) reported 15 species of fruits fed by the great pied hornbill (*Buceros bicornis*). In wreathed hornbill (*Aceros undulatus*) and the Oriental pied hornbill (*Anthracoceros albirostris*) Dutta (2000) has reported 51 plant species exploited and dispersed by the hornbills. Insect food in the breeding time may be because of the increased demand of calcium or animal proteins for the faster growth of the juveniles.

Though we represented data on mean number of time spent on the nests, sometimes the bird spent exceptionally long time near the nest, but such visit data has not been included for calculations and the values were treated as outliers.

Mobbing of the predators seems to be a common phenomenon and has been reported earlier (Abdulali 1976). Though eagles are unable to catch the nestling, they may be potential predators to fledglings and probably due to this reason the hornbills are hostile to the eagles. The water monitor lizard (*Varanus salvator*) may rob female and young from the nests. However, as pointed out in case of the Malabar grey hornbill (*Tockus griseus*) by Muddapa (2000), such possibilities are remote.

Narcondam hornbills did not show any obvious inter- or intra-specific competition for nesting and feeding resources due to the availability of adequate number of nesting trees and fruit species on the Island. However, this study started after the pairs had mostly settled for nesting. Such competition might have existed in the initial stages of nest site selection.

Like barbets (*Megalaima* spp.) and many other birds (Yahya 1987, 1990) hornbills follow a regular pattern of pre and post-roosting activities. They congregate at sunset flying high in irregular follow my leader style over fixed routes for roosting in selected patches of giant bamboo or thinly foliaged trees (Ali and Ripley 1983).

Recommendations

1) There should be no further expansion of the camp and a meterological sub-unit should be maintained with the available staff to keep track of the physical environment. The vegetation structure and composition of the Island should be studied properly. Research on the habitat requirement, breeding success and behaviour is important for the rational management of this endemic species.
2) Hussain (1984) suggested captive breeding and introduction of the species on to some ecologically similar nearby and uninhabited island. We support his idea of introduction, as giving an alternate home may bring additional security for this isolated species.
3) Most of the introduced goats, which were a serious problem on the Island have been removed recently. Still one can see groups of three to four feral goats near the campsite or else where occasionally, and should be removed immediately.

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NOTES ON NEW RECORDS OF HOOKTIP MOTHS, LEPIDOPTERA: DREPANIDAE, FROM THE KUMAON AND GARHWAL HIMALAYA[1]

PETER SMETACEK[2]

Key words: Hooktip moths, Drepanidae, Kumaon, Garhwal, Himalaya, Lepidoptera

Five genera and nine species are added to the known fauna of Kumaon and Garhwal Himalaya. Information on the behaviour, ecology and distribution of ten Drepanid species is noted.

INTRODUCTION

The Drepanidae are often referred to as Hooktips, since the forewing apex of many species is hooked. It is chiefly a tropical and sub-tropical family of moths with about 800 species worldwide. Of these, about 107 species occur in the Indian subregion (Jairajpuri 1991), mostly in Northeast India.

The family is placed in the superfamily Geometroidea and its closest relatives are the families Cyclididae, Thyatiridae and Epiplemidae. Two subfamilies are represented in India, Drepaninae and Oretinae. Only the former subfamily is dealt with in the present paper. It is distinguished from Oretinae by the presence of a functional proboscis in both sexes and a frenulum in males.

Little is known about the early stages of Indian Drepanidae. The present material is based on records and observations concerning adults. The known larval host plants of the Drepaninae in India belong to Myrtaceae (*Eugenia* L.), Rosaceae (*Rubus* L.), Palmae (*Phoenix* L.), Fagaceae (*Quercus* L.) and Zingiberaceae (*Amomum subulatum* Roxb.). None of the members of this family are known to be chemically protected, and therefore they depend largely on camouflage to avoid observation. Some have gone so far as to shed nearly all of the scales on their wings, leaving them practically transparent. Settled with outspread wings against any background, they are very difficult to distinguish unless one has observed them settling.

In the systematic section, unless otherwise mentioned, the known distribution of the species has been excerpted from Hampson (1892). The new records noted in this paper are with reference to this information.

LOCATION

The administrative division of Kumaon occupies a section of the Himalayan range west of Nepal. Together with the neighbouring division of Garhwal, it constitutes the headwaters of the Ganga river system. Osmaston (1927) divided the ranges of Kumaon into five climatic zones: the first is the submontane tract below the southern foothills, called the Bhabar. The second, which receives the heaviest rainfall in the area (up to 300 cm annually), extends from where the submontane tract meets the hills to the crest of the outermost range of hills. The third zone, which receives up to 200 cm of rainfall annually, is the largest zone, extending from the crest of the outermost hills to the crest of the outermost mountains of the main range. The fourth zone, which receives a maximum of 100 cm annually, is the main Himalayan range, while the fifth is the trans-Himalayan area north of the main range, which receives the least precipitation annually, up to 30 cm. In the present study, Drepanidae species have been recorded only in the second zone in Kumaon, where the Bhimtal valley and Maheshkhan are situated. Two species have been recorded at Joshimath and

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Khiron. The latter two locations are in Garhwal and, were Osmaston's (1927) divisions to be extended to Garhwal, they would be in the fourth zone, i.e. the main range.

Bhimtal town lies 22 km by road southeast of the district headquarters of Nainital, while Maheshkhan lies roughly 19 km east of Nainital. The main study site in Jones Estate, 2 km from Bhimtal town, is at an elevation of 1,500 m while Maheshkhan is 2,100 m above msl. Joshimath (1,750 m) is a large town in Chamoli district of Garhwal, while Khiron is a village and valley south of the town of Badrinath in the same district.

Duration

The present ongoing study has been undertaken more or less continuously for two decades and sporadically for a few years before that. Hence, observations regarding relative scarcity, annual generations, etc. are based on a long term perspective. The observations were more or less restricted to the Bhimtal valley and its vicinity, and projections concerning the distribution of species within Kumaon are necessarily based on indirect data, as discussed further on.

Attractants

All the specimens examined except *Macrauzata fenestraria* Moore were attracted either to mercury vapour lamps of 125 or 160W, or to tungsten filament lamps of 60 or 100W. In some moth families, it has been observed that females are less frequently attracted to artificial light, sometimes not at all. In the present study, both sexes of all species were attracted to light except *M. fenestraria,* which was recorded under exceptional circumstances, and *Teldenia vestigiata* Butler, *Drepana innotata* Hampson and *Tridrepana sadana* Moore, of which only females have been recorded so far. As has been discussed in the systematic section, this is probably due to the absence of males from the area within the ambit of the light, rather than the unattractiveness of such light for them.

In the case of *M. fenestraria*, the specimens were found dead in a pool where they had evidently come to drink water. None of the other species were recorded at water, but this does not mean that they do not visit water to quench their thirst.

None of the species was ever found on over-ripe fruit, sap or other sugar based attractants. However, it is not unlikely that they visit certain flowers.

Material Examined

Drepanid species are known to be generally scarce, and never found in large numbers. Several of the species discussed are known by one or two specimens from Kumaon. Such singletons are almost certainly stragglers, although not necessarily from outside Kumaon. The remaining species appear more or less regularly, especially *Albara violacea* Butler, *Tridrepana albonotata* Moore and *Callidrepana argenteola* Moore. In these cases, only a few specimens of all those attracted were taken. The specimens not taken were noted separately, but since they add nothing new to the matter under discussion, all reference to them has been omitted in this paper. Photographs have helped place additional specimens, as in the case of *Tridrepana sadana* Moore and *Drepana pallida* Moore.

Flying Time

With the exception of *Albara violacea*, the present paper deals with species that have so far been recorded only during and immediately after the Southwest monsoon, i.e. from June to October. Several species of the family are on the wing in spring, from February onwards, but they have not been included here.

All the species recorded from Bhimtal in the present paper, except *A. violacea*, were on the wing when relative humidity was over 30%. Perhaps humidity is of importance in the relatively drier area west of Nepal and these species will have more broods annually in the humid eastern Himalaya and N.E. India.

Dispersal and Population Dynamics

Although several of these moths are robustly built, are powerful flyers and have functional mouthparts, their power of dispersal appears to be rather limited. With some moth families, such as the Limacodidae, which lack functional mouthparts, their limited power of dispersal is understandable. Factors constraining the Drepanidae, however, are still obscure. Examples of this are *Teldenia vestigiata*, *Drepana innotata* and *Tridrepana sadana*, but especially *Macrauzata fenestraria*, which has not ventured across the relatively short distance between Maheshkhan and Bhimtal, at least during the last three decades. The former three, too, do not appear to be notable travellers, with what seem to be odd stragglers reaching the study site in Bhimtal.

As has been noted earlier, these moths are never common. Population outbreaks have never been noted, although population levels increased during the years of heavy rainfall between 1979 and 1983, and subsequently plummeted in the wake of repeated forest fires in the post-1984 period, which was followed by several drought years during the late eighties.

Zoogeography

At the generic level, the known Drepanid fauna of Kumaon includes *Macrocilix* Butler, *Macrauzata* Butler, *Auzata* Walker, *Deroca* Walker, *Bapta* Stephens, *Oreta* Walker and *Albara* Walker. The present paper adds *Teldenia* Moore, *Leucodrepana* Hampson, *Callidrepana* Felder, *Drepana* Schrank, *Tridrepana* Swinhoe and *Spica* Swinhoe. The new records of *Leucodrepana* and *Drepana* are not remarkable, since one or more species of *Leucodrepana* were expected to be found along the Himalaya above 2,500 m, and species of *Drepana* had been recorded both east and west of Kumaon, so one species or other was certain to be found.

The new records of *Teldenia*, *Callidrepana* and *Tridrepana* are not unusual, since they are widespread in the Indo-Malayan area. Given the Indo-Malayan area affinities of most of the Lepidopteran fauna of Kumaon, their absence was more remarkable than their presence. The interesting record is that of *Spica* from the main range. A number of other moth and butterfly species are restricted to the main range, even though conditions exist that would probably support their populations in the outer ranges (Smetacek, P. unpublished data). The factors restricting the distribution of such species to the main range will certainly prove to be interesting when they are discovered.

It is not certain that *Spica* does not occur in the outer ranges. However, if it did, its habit of being attracted to light and sitting there the whole day, even in towns, would have drawn attention to it. It has been recorded at 3,800 m in Nepal (Ebert 1966), so it might be a high elevation species, therefore restricted to the main range. The presence of this species in Joshimath at 1,750 m elevation might repay further study in understanding its ecology better.

Systematic Section

Macrauzata Butler
1889. Illust. Typ. Spec. Lep. Het.
in the Brit. Mus. vii: 43.
Macrauzata fenestraria Moore
1867. Proc. zool. Soc. Lond.: 639.

Material Examined: 4 exs.: 4.vi.1998 Maheshkhan 2,100 m x 4 (2 male, 2 female).

Forewing Length: 22-26 mm.

Expanse: 60-66 mm (Hampson 1892); 46-54 mm (*mihi*).

Distribution: Kangra (Himachal Pradesh), Sikkim; Japan.

Remarks: Hampson (1892) described only the female, for which the above measurements were given. Of the material examined, the males are smaller with a forewing length of 22-23 mm, while both females have a forewing length of 26 mm. All the specimens examined are considerably smaller than those examined by Hampson.

The specimens were found dead, floating in a small pool formed by a forest stream, along with a large number of other Lepidoptera, especially butterflies. It is likely that the water of the stream was poisoned by insecticides and other chemicals from the apple orchards near its source, for several butterflies that came to drink water while I was there died and ended up floating on the water.

All four specimens retrieved from the water are in reasonably good condition, with the wings intact and the pattern readily discernible. The latter matches Hampson's (1892) description and depiction.

This seems to be a very local moth, for though it appears to be established at 2,100 m elevation in Maheshkhan forest, it has never been recorded from the Bhimtal valley, which is 600 m lower but adjoins Maheshkhan valley and is only a few air-kilometres away. It is robustly built, with a functional proboscis, so the distance should be easily within its potential dispersal range.

Watson and Whalley (1983) depict a Japanese species of the genus as *Macrauzata maxima* Inoue, so *fenestraria* probably does not occur there, although Hampson included Japan.

Teldenia Moore
1882. Lep. Ceyl. ii: 119.
Teldenia vestigiata Butler
1880. Ann. Mag. Nat. Hist. (5) vi: 222.

Material Examined: 14 exs.: Males: 9.viii.2001, 15.viii.2001, 17.viii.2001, 18.viii.2001, 20.viii.2001; Females: 29.vii.2001, 8.viii.2001, 12.viii.2001, 16.viii.2001, 17.viii.2001 x2, 20.viii.2001, 31.viii.1997, 5.ix.1997.

Forewing Length: 10-12 mm.

Expanse: 25 mm (Hampson 1892); 22-26 mm (*mihi*).

Distribution: Sikkim, Nagas; Sri Lanka.

Remarks: The present record extends the known distribution of the genus and species westward to Kumaon. Only one brood has been noted, but there would probably be a second brood earlier in the year. It is a small, inconspicuous moth, easily overlooked since it is not common and never appears in numbers. It is commoner in some years than in others, eg. in 2001 it was commoner than in the proceeding years.

The specimens examined match Hampson's (1892) description and depiction. In the matter of size, some are a little smaller and others a little larger than the specimens examined by Hampson, which were males. Therefore, it appears that there is little difference in size between the sexes.

The species is on the wing during periods of high atmospheric humidity, generally over 35% indoors and over 40% outdoors. It has been bred on *Eugenia firma* (Myrtaceae) in Sri Lanka according to Sevastopulo (1940). This tree does not occur in Kumaon, but three other species of *Eugenia* do (Osmaston 1927), all within a 15 km radius of the main study area. If this moth feeds only on species of *Eugenia* in Kumaon, the present records are probably from the upper limit of its altitudinal range, since the larval host plant does not occur above this altitude.

Leucodrepana Hampson
1892. Faun. Brit. Ind. Moths I: 333;
Fig. 231 (male).
Leucodrepana idaeoides Hampson
1892. Faun. Brit. Ind. Moths I: 333;
Fig. 231 (male).

Material Examined: 1 ex.: 21.vii.1992

Khiron, Garhwal 3,600 m.

Forewing Length: 14 mm.

Expanse: 33 mm (Hampson 1892); 30 mm (*mihi*).

Distribution: Sikkim 3,048 m

Remarks: The single specimen examined was attracted to a campfire on a meadow just above the tree line. The present record extends the known distribution of the genus and species westward to Garhwal from the previously known localities in Sikkim and the Khasi Hills. The species will almost certainly be found in similar localities in Kumaon, although it has not been recorded so far. The present record also extends the altitudinal range by about 550 m, from the previous record by Hampson of 3,048 m to 3,600 m.

The specimen examined is slightly smaller than Hampson's type material. Whether this is within the acceptable limits or is characteristic of the western population will only be clarified by examining more specimens. The flight of this moth is weak and erratic. It settles with the wings held flat against the substrate in the manner adopted by most Drepanidae.

Drepana Schrank
1802. Fauna Boica II: 155.

Drepana pallida Moore
1879. Desc. New Lep. Ins. Coll. Atkinson. Het.: 84.

Material Examined: 6 exs.: 13.vii.1977; 12.vii.1990; 16.x.1993 (Females); 7.ix.1974; 9.ix.1997; 25.ix.1995 (Males).

Forewing Length: 20-26 mm.

Expanse: 44 mm (males), 60 mm (females) (Hampson 1892); 42-56 mm (*mihi*).

Distribution: Sikkim.

Remarks: A new record for Kumaon. This and the next species extend the range of the genus to Kumaon. It is bivoltine, with one brood on the wing in July and the second in September and October. It is a well established, if not very common insect in the Bhimtal valley. It ascends to at least 1,730 m, for I have noted it in the nearby town of Bhowali.

Females are generally larger than the males and have less brown suffusion on the wings. In fact, the light brown ground colour noted by Hampson (1892) varies considerably, with some specimens almost whitish and others suffused with brown. In other respects, the specimens match Hampson's description. The flight is rapid and direct.

In the matter of size, one male examined was smaller than the material examined by Hampson, while the females were not as large as Hampson's material. The latter seems a consistent trend, for some other females, examined in photographs, do not appear to be larger than 56 mm.

Drepana innotata Hampson
1892. Faun. Brit. Ind. Moths I: 335.

Material Examined: 1 ex.: 26.viii.1997 (Female).

Forewing Length: 20 mm.

Expanse: 36 mm (Female) (Hampson 1892); 44 mm (*mihi*).

Distribution: Kulu (Himachal Pradesh).

Remarks: The single female is the only specimen of this species seen so far in Bhimtal. It extends the known distribution eastwards to Kumaon. It is rather larger than the type material examined by Hampson. He stated that the wings are hyaline with a few scattered white scales, and absolutely without markings. However, the specimen examined has two very faint black postmedial spots on veins Cu_{1b} and M_3 of the forewing.

It is likely that this moth will be more frequently met in suitable localities, such as broadleaf evergreen forests at slightly higher elevation than the main study site, e.g. above 1,800 m. Such forests are home to other semi-hyaline or hyaline Drepanids such as members

of the genus *Deroca* Walker. The specimen examined was certainly a straggler in the process of dispersing the species. It seems that, like *Macrauzata fenestraria*, these moths do not generally travel far from favoured localities. However, the present record indicates that it is capable of greater dispersal than *M. fenestraria*.

Albara Walker
1866. Cat. Lep. Het. Brit. Mus., London xxxv: 1566.
Albara violacea Butler
1889. Illust. Typ. Spec. Lop. Het. in the Brit. Mus. vii: 42, pl. 124, fig. 7.

Material Examined: 7 exs.: 12.iii.1991, 1.iv.1991, 6.iv.2002, 13.vi.1983, 16.vii.2001, 20.ix.2000, 2.xi.2000.

Forewing Length: 17-19 mm.

Expanse: 38 mm (Hampson 1892); 36-40 mm (*mihi*).

Distribution: Dharamsala (Himachal Pradesh).

Remarks: A new record for Kumaon which extends the known distribution of the species eastwards. It is rare in the Bhimtal valley. There appear to be three annual broods, one in spring, the second in summer and the third in autumn.

The specimens examined add some information to the known expanse of the species with the specimens examined by Hampson forming a mean. In other respects, they do not differ from the description.

The appearance of this species in Kumaon is not unexpected, unlike *Spica luteola*. The other member of the genus found in Kumaon, *A. lilacina* Moore, is much commoner with an extended flying period. It is likely that other species of the genus will be recorded from biotypes not covered in the present study.

Callidrepana Felder & Felder
1867. Reise Frig. Novara Lep. p1. 83, fig.11. Erkl. p. 2.
Callidrepana argenteola Moore
1859. in Horsfield & Moore, Cat. Lep. Ins. Mus. Hon. East Ind. Co. Lond. II: 369.

Material Examined: 13 exs.: 27.viii.1997; 31.viii.1978; 5.ix.1997; 6.ix.1995 x2; 7.ix.1983; 10.ix.1997 x 2; 13.ix.1977; 25.ix.1999; l.x.1992; 9.x.1998; 10.x.1998.

Forewing Length: 15-22 mm.

Expanse: 35-45 mm (males); 50 mm (females) (Hampson 1892); 34-46 mm (*mihi*).

Distribution: Sikkim; Burma; Sri Lanka; Java (Hampson 1892); India to Taiwan, Malaya, Java, Sumatra, Borneo, Sulawesi (Barlow 1982).

Remarks: The present records extend the known distribution of the genus and species to Kumaon. There appears to be a single extended annual generation, which is on the wing from the end of August to mid-October. The lack of a spring generation may indicate the greater importance of high atmospheric humidity levels, rather than temperature or day length, in governing emergence patterns.

It is among the commoner Drepanids in the Bhimtal valley. This appears to be the altitudinal limit of the species, since I have not seen it at higher elevation.

The specimens examined agree with Hampson's (1892) description in all respects except in the size of the females, which are not as large as the specimens examined by Hampson.

Tridrepana Swinhoe
1895. Trans. Ent. Soc. Lond.: 3.
Tridrepana albonotata Moore
1879. Desc. New Lep. Ins. Coll. Atkinson. Het.: 83.

Material Examined: 9 exs.: 15.vii.1990; 25.viii.1993; 31.viii.1999; 10.ix.1977; 10.ix.1999; 11.ix.1977; 11.ix.1998; 25.ix.1999; 14.x.1995.

Forewing Length: 14-20 mm.

Expanse: 34-38 mm (Hampson 1892); 30-42 mm (*mihi*)

Distribution: Sikkim; Nilgiris (Tamil Nadu) (Hampson 1892); Oriental Tropics (Barlow 1982).

Remarks: A new record for Kumaon. This and the next species extend the known distribution of the genus to Kumaon. Although not a common insect, it is remarkably regular in the appearance of the brood, as can be seen from the records above that are more than twenty years apart. It seems that there is one extended brood, on the wing from the end of August to mid-October, with a smaller brood in July. It is also possible that the July record is that of an individual that emerged unusually early.

The specimens examined match the description given by Hampson (1892) as well as the male illustrated in Barlow (1982). However, the males are smaller and the females larger than the material examined by Hampson.

The species is well established in the Bhimtal valley, which is probably near its upper altitudinal limit. It might be commoner at lower elevation. Like several other Drepanids, it is on the wing during the wettest period of the year, which suggests that atmospheric humidity plays a major role in governing emergence patterns of the species.

Tridrepana sadana Moore
1865. Proc. zool. Soc. Lond.: 817.

Material Examined: 3 ex.:19.iv.2001 (female), 20.ix.2000 (male), 11.x.1998 (female).

Forewing Length: 20-24 mm.

Expanse: 40 mm (male) (Hampson 1892); 42 (male), 48-52 mm (females) (*mihi*).

Distribution: Sikkim.

Remarks: The specimens examined are placed tentatively under this species. It is a new record for Kumaon, from where this genus was hitherto not reported.

At least two other specimens of this species, identified from photographs, have been recorded in the Bhimtal valley previously.

The specimens examined are rather similar to the figure of *Tridrepana fulvata* Snellen in Barlow (1982), except for the size of the discal patch and the submarginal spots below the forewing apex, which are black in the specimen examined but brown in the figure. *T. fulvata* is from outside Indian faunal limits.

The specimens examined differ from Hampson's description of *T. sadana* in the following respects:

On the forewing *recto*, there is a brown-ringed white spot in the cell. A similar spot is situated at the lower angle of the cell, at the top of the large red-brown patch. There are traces of a postmedial line. On the hindwing *recto*, there is a brown-ringed white spot at the upper end of the cell and a similar, but smaller spot at the lower end of the cell.

The *verso* surface is unmarked, except for an obscure speck at the end of the cell and three prominent submarginal brown specks below the apex, which are repeated on the *recto* surface. The cilia below the apex of the forewing are brown.

The reason that the specimen examined has been placed tentatively under this species despite the abovementioned differences is that if this is an undescribed species or a species unknown to me, it will be possible to place it correctly on the basis of the points mentioned above.

There appear to be two annual generations, one in spring and the second in autumn. It is certainly a very rare moth in the Bhimtal valley.

Spica Swinhoe
1889. Proc. zool. Soc. Lond.: 424.
Spica luteola Swinhoe
1889. Proc. zool. Soc. Lond.: 424, pl. 44 fig. 10.

Material Examined: 4 exs.: 29.viii.1993, Joshimath, Garhwal 1,750 m x3; 2.ix.1993 Joshimath, Garhwal 1,750 m.

Forewing Length: 16-18 mm.

Expanse: 34 mm (Hampson 1892); 34-38 mm (*mihi*).

Distribution: Sikkim (Hampson 1892); Nepal (Ebert 1966).

Remarks: The present records extend the known distribution of the genus and species to Garhwal. Since it is known from both east and west of Kumaon, it will almost certainly be found in Kumaon. It is only known from the main Himalayan range and since little work has been carried out in this range in Kumaon, the fact that it has so far not been recorded is not remarkable.

It is attracted to tungsten filament lamps and all the specimens were collected at different locations in Joshimath town in the morning, below lamps that had been left on all night. The flight is rather weak and fluttering, unlike the Noctuids, which it superficially resembles. It seems to be the only Indian Drepanid besides *Cilix glaucata* Scopoli that rests with its forewings over its hindwings, both draped laterally over the abdomen, in the position usually adopted by Arctiids and Noctuids.

It was not recorded from other localities in Garhwal around Joshimath, where studies were carried out earlier in August. The brood is probably not on the wing until the end of August, as in the case of *Callidrepana argenteola*. However, in Nepal, Ebert (1966) found it about the village of Khumjung (3,800 m) in the main Himalayan range in July. Possibly, Joshimath is near the lower limit of its altitudinal range.

Discussion

Hampson (1892) recorded 14 species of 9 genera from the Himalaya west of Nepal, of which one species was treated as a Geometrid by him. No species were specifically recorded from Kumaon at the time. Subsequently, members of all nine genera, except *Cilix* Leach, have been recorded from Kumaon. *Cilix* will probably be found at higher elevation, i.e. above 1,600 m or in the main Himalayan range eventually. It has not been recorded mainly because no one has really looked for it.

The present paper adds five genera, i.e. *Teldenia*, *Leucodrepana*, *Callidrepana*, *Tridrepana* and *Spica,* and nine species to the known Drepanid fauna of Kumaon and Garhwal. The new records in the present paper constitute *c.* 35% of the Drepanid fauna of this area, in terms of species as well as genera. There are several unidentified species in my collection, so the figure for species, if not for genera, will increase.

The difficulty with surveying the Drepanidae is that firstly, in this area, they are on the wing for a rather limited period, the exact timing varying from species to species, as well as with altitude, local weather conditions and probably several other factors not understood at present. Secondly, they are local insects, not given to much travelling, unlike large moths such as the majority of the Hawkmoths. Therefore, the observer has to be in the right place at just the right time. Thirdly, they are generally scarce insects. Although it is possible that some species are common in favourable habitats, they are never attracted in large numbers to artificial light, the only known attractant at present. It is not remarkable for this family that some species, like *Drepana innotata*, have been recorded only once in over twenty years at the main study site, although it will probably be found to be well established in a biotype not far from Bhimtal in due course. *M. fenestraria* has not even appeared so far at the main study site, although it is evidently well established a few air-kilometers away in Maheshkhan.

In keeping with the trend observed in the Sphingidae (Smetacek 1994) and butterflies (Smetacek 1995, 2001; unpublished data) in Kumaon, most of the new records are Indo-Malayan species or genera. The range of only two species is extended eastwards. These are

Albara violacea and *Drepana innotata*. While the former appears to be a well established resident, the latter is a straggler but presumably not from very far away. It is impossible to say whether the remaining new records are recent colonists or have been established for centuries, since there is no reference material to fall back upon. Therefore, the present material must serve as base-line data for future studies.

It is noteworthy that except for *Drepana innotata* and *Tridrepana sadana*, none of the species display any variation from the material described by Hampson or, in the case of *Tridrepana albonotata*, from the Malayan specimen illustrated in Barlow (1982). There seems to be very little geographical variation among the species treated in this paper. Nor has any seasonal variation been noted among them.

The only difference between Hampson's specimens and the present ones appears to be in the matter of size, but even in this, there are no consistent trends and most of the differences may be attributed to the greater number of specimens examined in the present study.

The flying time of Drepanids appears to be remarkably regular in this area, with hardly any stragglers. This is not often the case in other moth families. Minor upsets in the weather are often enough to cause the unseasonal appearance of Noctuids, Geometrids and members of several other families. Even the unusually early Southwest monsoon in 1999 and 2000 in this area did not affect Drepanid emergence patterns at all. During drought years and in the wake of major forest fires, populations tend to drop, sometimes steeply, but the same can be said for all other moth families.

Although two species in two genera, i.e. *Leucodrepana idaeoides* and *Spica luteola* have not been recorded from Kumaon so far, the fact that they have been recorded from both east (Nepal and Sikkim) and west (Garhwal) of here implies that they will almost certainly be found in similar habitats in Kumaon.

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REVISION OF FIVE KNOWN SPECIES OF FAMILY ASSAMIDAE, LANIATORES: OPILIONES, ON THE BASIS OF TYPES AND IDENTIFIED SPECIMENS DEPOSITED IN THE ZOOLOGICAL SURVEY OF INDIA NATIONAL COLLECTION, BY ROEWER (1911-1939)[1]

(*With forty-five text-figures*)

D.B. BASTAWADE[2]

Key words: Revision, types, Opiliones, Palpitores, Laniatores, Assamidae, *Puria dorsalis*, *Assamiella marginata*, *Neassamia aborensis*, *Anassamia rufa*, *Assamia punctata*

Several new genera and species of the Indian Opiliones of suborders Palpitores and Laniatores have been described by Roewer (1911-1939). About 30 species under Suborder Palpitores have been revised by Deshpande (1987), but many are yet to be studied and redescribed. Laniatores, which requires revising and updating, is another major Suborder of Opiliones, constituting 2 large and 2 small families, with a large number of species described from the Indian subcontinent. This communication deals with the revision of 5 species belonging to the Family Assamidae, on the basis of types and identified specimens deposited by Roewer in the National Collection of the Zoological Survey of India, Kolkata. The species dealt here are *Puria dorsalis* (Roewer), *Assamiella marginata* (Roewer), *Neassamia aborensis* (Roewer), *Anassamia rufa* (Roewer) and *Assamia punctata* Roewer.

Indian Opiliones are divided into two major suborders: Palpitores, commonly termed as Daddy long-legs, having unarmed, slender palps bearing distally a minute spine each, body generally large, with smaller numbers of long prominent spines and with comparatively long legs. Laniatores, with broad, expanded and shovelled-in palps armed on inner margins with long, pointed, curved spines and also ending in long piercing spines; body generally smaller with a number of small, tuberculate spines, legs generally short and weak. Indian Laniatores are composed of four families 1. Oncopodidae, 2. Assamidae, 3. Phalangodidae and 4. Gonyleptidae (Martens 1972-78). Families 2 and 3 are larger, with 67 and 12 genera respectively, while 1 and 4 are minor, with only 2 and 1 genera each. Roewer (1911-1939) has described numerous new genera and species under both these suborders, and many of the types and identified specimens have been deposited in the National Collections (NC) of the Zoological Survey of India (ZSI), Kolkata. About 30 species, belonging to the suborder Palpitores, have been revised and 1 new genus and 11 new species added by Deshpande (1987). The types of Indian Laniatores remain to be studied and revised. This is an attempt to redescribe five species of Family Assamidae on the basis of types and identified specimens deposited in the NC, ZSI, Kolkata.

1. *Puria dorsalis* (Roewer)

(Figs 1-11)

1914. *Assamia dorsalis*: Roewer, *Arch. Natur.,* 80A (9): 106-132.

1923. *Puria dorsalis*: Roewer, *Die. Weber. Erde.*: 1116.

Lectotype: 1♀ Yellowish orange, light yellow on appendages, dorsum finely granular,

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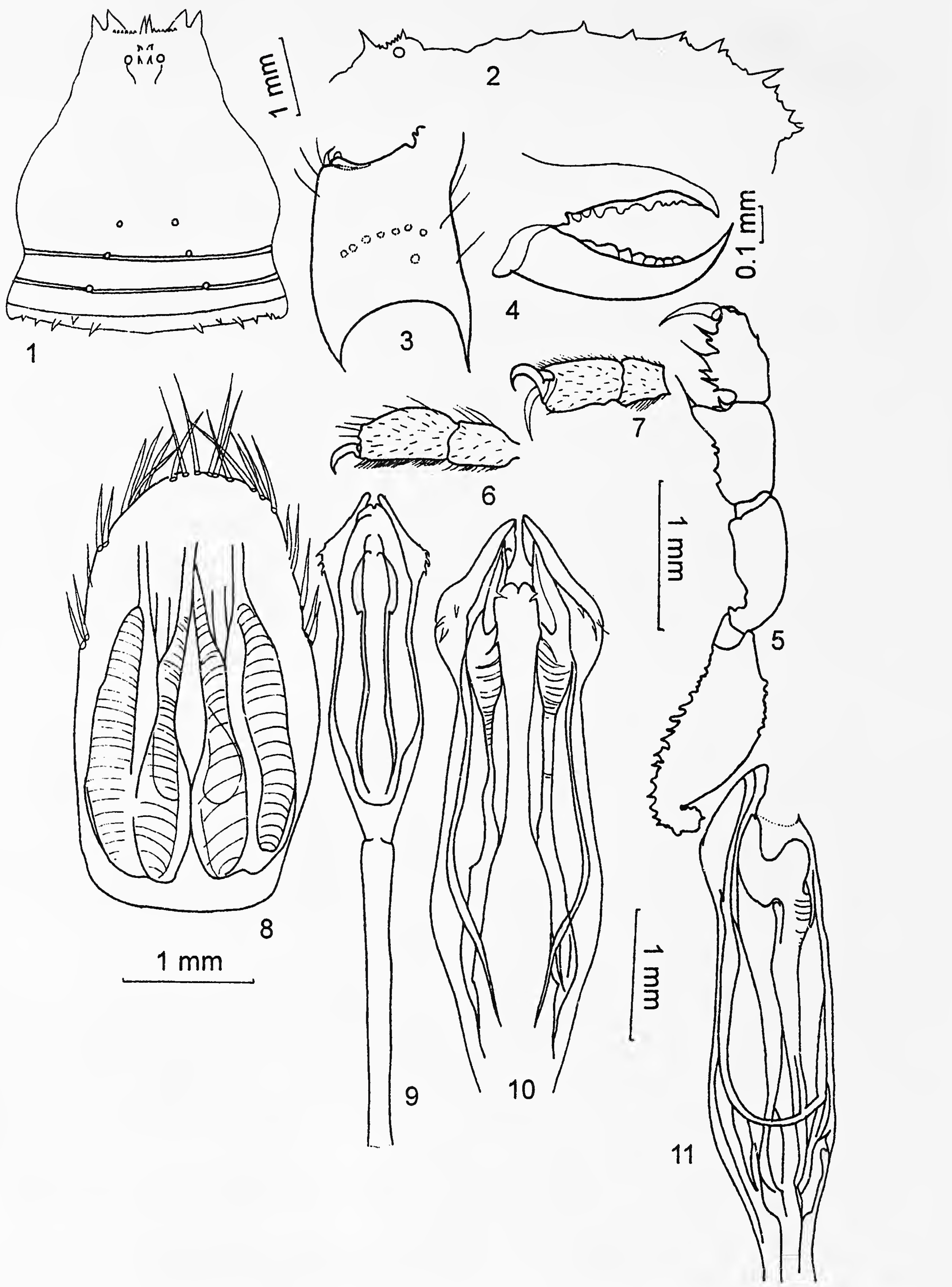


Figs 1-11: *Puria dorsalis* (Roewer), 1. Carapace, dorsal aspect, 2. Carapace & abdomen, lateral aspect, 3. Chelicera (basal segment), ventral aspect, 4. Movable and immovable fingers of chelicera, lateral aspect, 5. Palp, lateral aspect, 6. Tarsus & claw of leg I, lateral aspect, 7. Tarsus & claw of leg IV, lateral aspect, 8. Ovipositor, ventral aspect, 9. Penis, ventral aspect, 10. Penis (distal portion), ventral aspect, 11. Penis (distal portion), lateral aspect

more granular on anterior portion, anterior margin with a pair of short median spines, with a pair of more tuberculate spines on each side, lateral margins smooth, bearing small tuberculate spine at level of median eyes, anterior margin supported by a granular sub-marginal ridge, few granules tuberculate and raised with an anterior median spine anterior to the pair of median eyes, ocular tubercle also raised, granular, with a pair of small tuberculate spines, wider than long, followed by a prominent median furrow, posterior 4 segments superficially marked by faint sutures, each with a pair of small to medium tuberculate median spines, posterior margin tuberculate but a sub-median pair prominent and large, rest of the tergites also bear same tubercles on posterior margin, last tergite bears 10-12 small tuberculate spines (Figs 1 & 2). All tergites finely granular; female ovipositor as in Fig. 8, male penis as in Figs 9 (dorsal view), 10 (ventral view, only distal portion) and 11 (lateral view, only distal portion). Chelicera three segmented, 1st segment bulging on anterior dorsal portion, basal segment almost twice as wide as long, smooth except for reticulate dorsal surface, armed with 7+2 ventral, 3+3 outer setae at base of movable finger, 4+4 on outer frontal surface and 3 inner/mesal setae at the base of immovable finger, movable finger armed with serrula of 8 minute teeth on inner margins, immovable finger armed with 7 broader cutting teeth on inner margins (Figs 3 & 4). Palp with short trochanter, carinated, granular, one or two distal granules denticulate; Femur laterally flat, carinated, anterior and posterior carinae crenulate, exterior carinae with 13-15 denticulate granules, inner distal surface provided with sub-apical small tuberculate denticle; Patella shorter than femur, expanded laterally on dorsal portion, carinated and inner carinae provided with 4-6 denticulate tubercles, outer carinae crenulate, but weak, and a few denticulate tubercles present on distal portion. Tibia longer than patella but shorter than femur, almost quadrangular, inner surface flat, marginated with strong but smooth carinae and outer carinae provided with a large pointed apophysis, few spines and tubercles supporting the apophysis, inner carinae also smooth and obsolete but armed with two elongated, pointed spines without apophysis. Metatarsus shorter than tibia, more flat, widened on outer portion provided with 2 long, 2 moderate and 4-5 small spines in series, inner ventral margin with two long spines but shorter than present on tibia. Tarsus with spines, elongated, sharp and curved but shorter than metatarsus. Inter-carinal space on all segments smooth. Legs with coxae I granular, all granules tuberculate and arranged in three rows, first row with 7-9 larger granules, distally armed with a pair of claws (Fig. 7), II-IV with a few obsolete granules, leg I with 6 digits in metatarsus, leg II with 12 digits while legs III & IV bear 7 digits each, distally armed with a single claw each (Fig. 6).

Measurements: Cephalothorax 5.17 mm long.

Material Examined: **Lectotype** 8 ♀♀, 7 ♂♂; **Locality**: Helwak, 2000' elev., Koyna Valley, Satara district, Maharashtra; Coll. ? [initials on label] Roewer, 1914, No. 3091, ZSI, Type Regn No. 2127/17.

Paralectotypes: 1) 1♀, 1 ♂ Tambi, 2500' Koyna valley, Satara district, Coll. F.H. Gravely,

Table 1: Measurements in mm for the palp and legs I-IV of *Puria dorsalis*

	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Palp	0.66	1.65	0.99	0.86	1.43		5.61
Legs I	0.44	1.43	0.88	1.54	1.65	1.21	7.15
II	0.55	3.96	1.10	3.63	3.74	2.97	15.95
III	0.66	3.08	1.21	2.20	3.30	1.65	12.10
IV	0.77	4.29	1.10	2.06	4.73	1.32	15.07

24-26.iv.1912; det. ?? Roewer, (1914) No. 3087, ZSI, Type No. 2124/17.

2) 1 ♀ East side of Koyna valley, 3500' Satara district, Coll. F. H. Gravely, 24.iv.1912; det. ?? Roewer, 1914, No. 3098, ZSI Type No. 2132/17.

3) 1 ♀, Helwak, Koyna, 2000' Satara district, Coll. F.H. Gravely, 28-30.iv.1912, det. ?? Roewer, 1914, No. 4003, ZSI Type No. 2103/17.

4) 1 ♀, 2♂♂ Naithal, 2000' Western Ghats, Satara district, Coll. ?, dt. ?, det. Roewer 1914, No. 3096, ZSI Type No. 2130/17.

5) 1 ♀, Palghar, Ratnagiri district, Coll. ?? Agharkar, 1.xi.1912, det. Roewer, 1914, No. 4001, ZSI Type No. 2100/17.

6) 2♂♂ Mumbai (Bombay), Coll.?, dt.?, det. ?? Roewer, 1914, No. 3079, ZSI Type No. 1559/17.

7) 1♂, Hill track garden, Coonoor, S. India, Coll. Capt. Samuel, det. ?? Roewer, 1914, No. 3069, ZSI Type No. 1552/ 17.

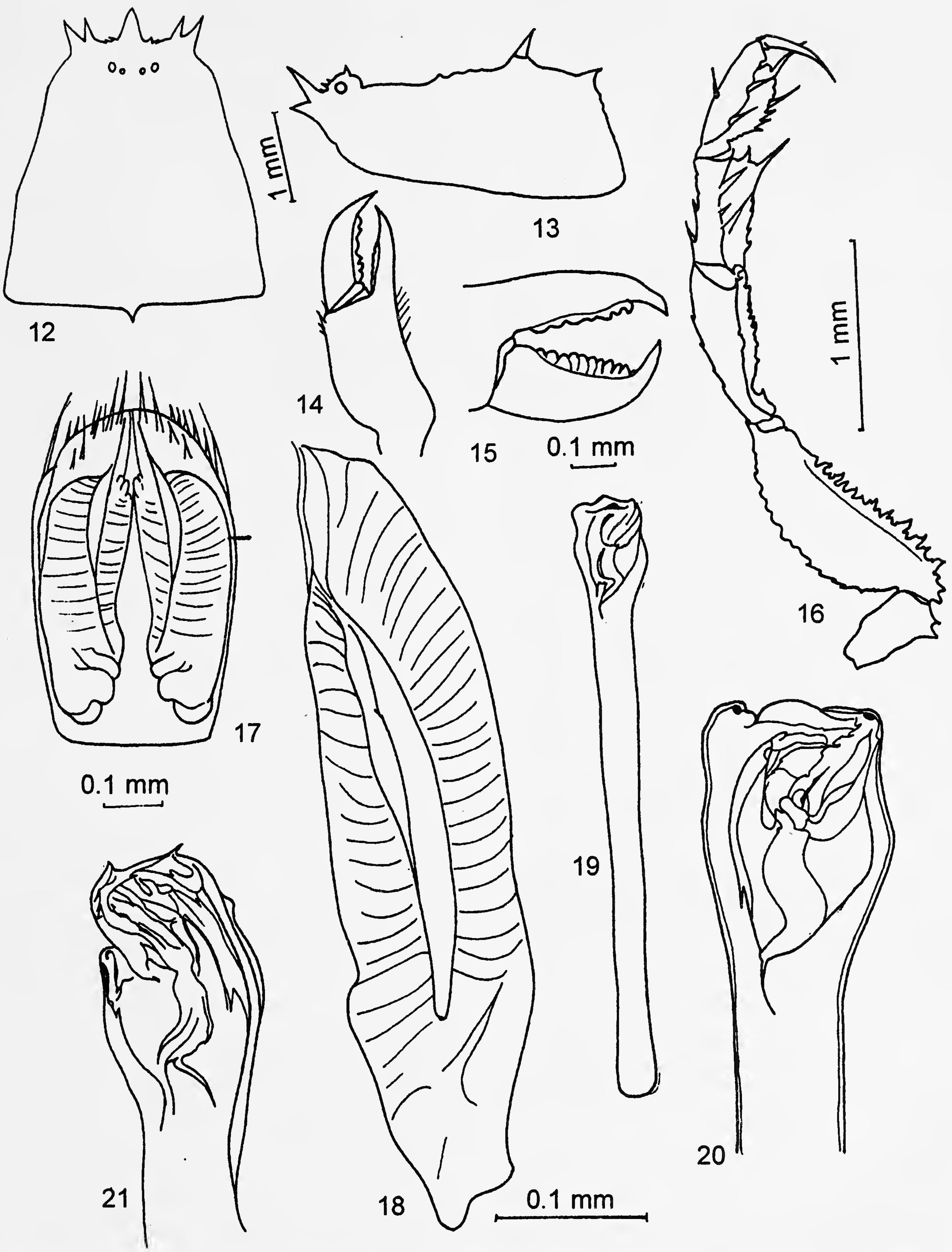
8) 1♂, Hill above Barkud, 200-500' Puri district, Coll. F.H. Gravely, 11-13.xi.1912, det. ?? Roewer, 1914, No. 4004, ZSI Type No. 2101/17 (kept in micro-vial).

2. *Assamiella marginata* (Roewer)
(Figs 12-21)

1912. *Assamia marginata*: Roewer, *Arch. Natg. Berlin,* 78(3): 38.

1929. *Assamiella marginata*: Roewer, *Die wetr. der Erde*: 1116.

Lectotype: 1 ♀ dorsum finely granular throughout and granules concentrated in furrows, lateral margins and around tubercles, anterior margin with a short median spine and two lateral spines, longer than median, margins supported with smooth sub-marginal ridge, surface medially raised into an erect, elongated spine, more than as high as ocular tubercle, lies between anterior median marginal spine and ocular tubercle; ocular tubercle with a pair of median eyes, wider than as long and also as high, with an anterior and a posterior pair of rudimentary tubercles, median furrow distinct, shallower laterally, posterior portion with four sutures, all with few larger scattered granules and 3rd with a pair of backwardly directed spines; tergites and sternites finely granular, with granular posterior margins (Figs 12 & 13). Female ovipositor as Figs 17 & 18 and male penis as Figs 19 (ventral view), 20 (dorsal view, only distal portion) and 21 (lateral view, only distal portion). Chelicera three segmented, 1st bulging on anterior dorsal portion, basal segment almost twice as long as wide, dorsal surface covered with obsolete ridges — otherwise smooth — with a single seta at base of inner margins of movable fingers, followed by one pair of setae, 4 setae on inner margins, 3-4 on outer surface at the base of movable fingers, ventral surface with 1 seta at the base of movable finger, and 2-3 short setae in series in middle portions, immovable fingers armed with 6 small, triangular cutting teeth grouped 3+3 on inner margins, movable fingers provided with a serrula 7-8 rounded teeth (Figs 14 & 15). Palp with elongated trochanter, widened distally, provided with a pair of ventral tuberculate granules, carinated but carinae weakly crenulate. Femur compressed laterally, bent inward, carinated and outer or exterior carinae coarsely crenulate with 18-20 crenulated tubercles (Fig. 16), inner or interior carinae with continuous crenulations. Patella shorter than femur, widened on distal portions, almost quadrangular on middle portions, carinated, inner carinae with even, small, sparsely spinulate crenulations ending distally into sub-tuberculate spines, exterior carinae weakly crenulate to obsolete. Tibia shorter than patella, wider at distal inner-lateral portions, margins ending in an apophysis, armed with a strong spine and an additional sub-tuberculate spine, inner carinae armed with 2 long spines and a few short spines, outer carinae weakly crenulate to obsolete. Metatarsus wider on outer margin, inner surface concave, lateral outer margin ending spiniform, armed with 2 long, pointed and few short spines; inner



Figs 12-21: *Assamiella marginata* (Roewer), 12. Carapace, dorsal aspect, 13. Carapace, lateral aspect, 14. Chelicera, ventral aspect, 15. Movable and immovable fingers of chelicera, lateral aspect, 16. Palp, dorso-lateral aspect, 17. Ovipositor, ventral aspect, 18. Ovipositor (left enlarged portion), ventral aspect, 19. Penis, ventral aspect, 20. Penis (distal portion enlarged) ventral aspect, 21. Penis (distal portion enlarged) lateral aspect

Table 2: Measurements in mm for palp and legs I-IV of *Assamiella marginata*

	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Palp	0.66	1.320	0.88	0.770	1.10		04.73
Legs I	0.44	0.242	0.66	0.165	0.275	0.165	09.57
II	0.44	0.396	0.77	0.385	0.473	0.352	17.27
III	0.55	0.330	0.99	0.198	0.264	0.143	10.89
IV	0.55	4.290	1.10	2.750	5.390	1.320	15.40

margin armed with 2-3 elongated spines, other carinae smooth and obsolete. Tarsus spined but spines shorter than metatarsus, curved and pointed sharply (Fig. 16). Legs I-IV coxae granular, coxa I with 5-6 tuberculate granules on anterior distal end, proximal inner margin with a series of 7-8 granules, strongly tuberculate, middle portions with rows of 9-10 granules, while posterior margins bear 10-11 tuberculate granules; coxae II with 11-12 granules on anterior margins, 10 granules on median rows, 8-9 in posterior rows; coxa III with 8-9 granules on anterior and on posterior margins; coxa IV with a few tuberculate granules on outer surfaces, posterior margins with 2-4 tuberculate granules; sternite I with 2-4 elongated tuberculate granules on lateral sides at coxal levels. Leg formula 2431.

Measurements: Cephalothorax 3.52 mm long.

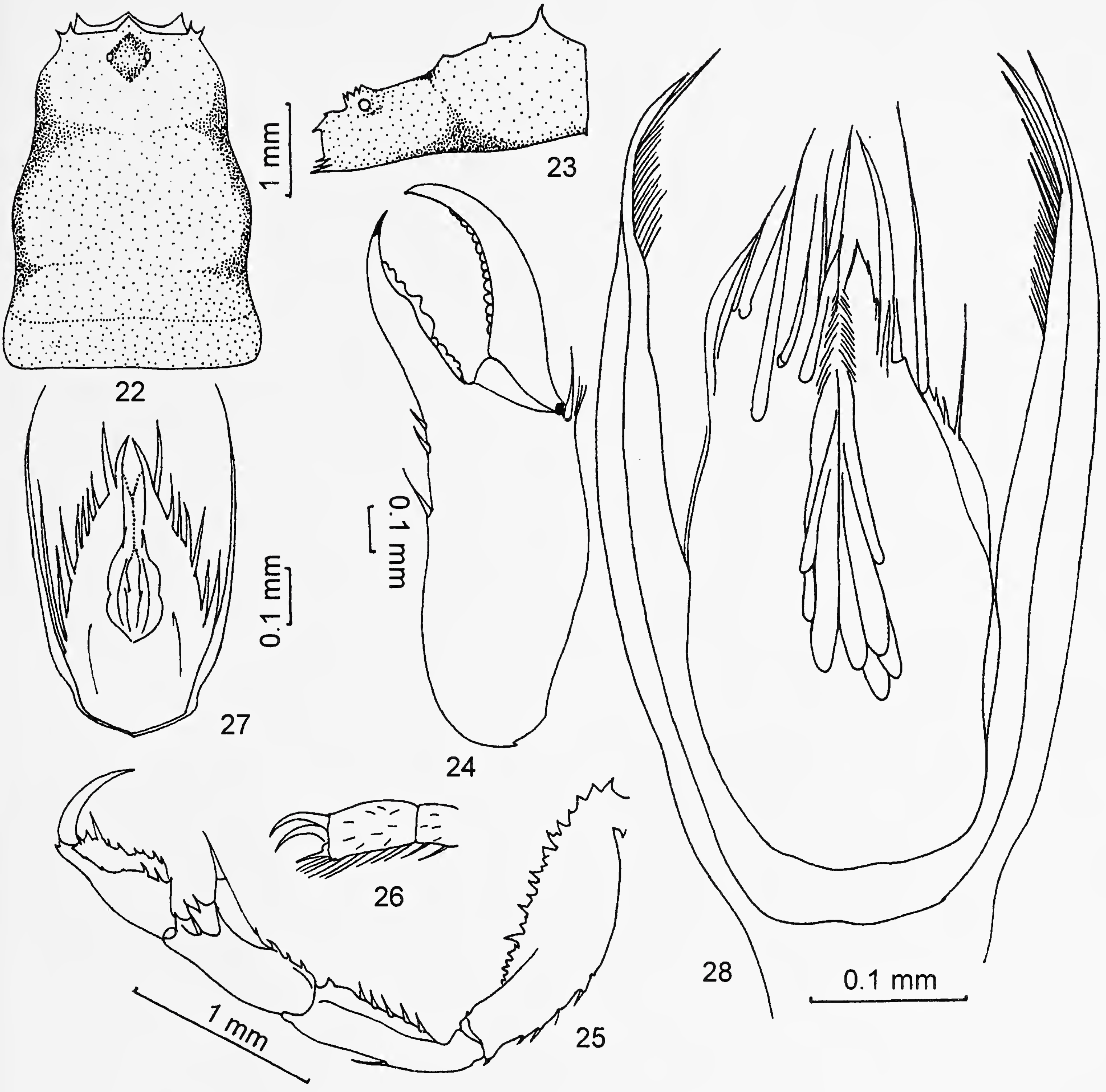
Type-Data: Lectotype 1♂, 2♀♀, **Locality**: Misty hollow, Western sides of Dawana Hills, 2200', Coll. F.H. Gravely, 22-30.xi.1911, det. ?? Roewer, 1912, ZSI Type No. 1182/17.

3. ***Neassamia aborensis* (Roewer)**
(Figs 22-28)

1913. *Assamia aborensis*: Roewer, *Rec. Indian Mus.*, 8: 203-207.

1935. *Neassamia aborensis*: Roewer, *Veröff. dtsch. Kolonial-u. Übersee-Mus.* 1(1): 36.

Lectotype: 1♀ Cephalothorax thickly but finely granular, forming granular ridge along anterior submarginal line, posterior margin with small, inconspicuous spinules, three pairs of lateral prominent spines (middle spine less conspicuous, short), no spine between anterior median spine and ocular tubercle, ocular tubercle wide, thickly granular on anterior portion with 3 pairs of prominent granules, 1 moderate and 2 rudimentary pairs of tubercles on posterior margin, shallow but distinct furrows on posterior lateral and posterior median portion of eyes (Figs 22 & 23). Abdominal tergites and sternites also with fine but sparse granulation. Female ovipositor as in Figs 27 & 28. Chelicera bulging on outer portion of 1st segment, granular on exterior portion, basal segment globular and granular, with 3 spinulate bristles on inner surface, 3 at base of movable fingers and 2-4 at base of immovable fingers, immovable finger with cutting inner edge bearing 5-6 minute teeth, whereas movable fingers with inner edges bearing 8-10 very minute teeth (Fig. 24). Palp with elongated trochanter, with 1 or 2 sub-tuberculate granules on distal ventral surface. Femur laterally compressed, partially twisted inwards, carinated, outer carinae with 8 large and 11 small double-headed tuberculate crenules, inner carinae weakly crenulate to obsolete on proximal portions. Patella shorter than femur, expanded or dilated distally, quadrangular, carinated, inner carinae sparsely and weakly to poorly crenulate, ending distally in erect sub-denticulate spines. Tibia shorter than patella, expanded on outer sides and armed with strong apophysis with elongated acutely pointed spines, inner ventral margins crenulate, armed with 2 elongate sparsely separated spines, outer carinae obsolete. Metatarsus shorter than tibia, expanded on inner side, margin armed with 2 widely separated strong spines, a few other spines short and stout, only inner ventral carinae



Figs 22-28: *Neassamia aborensis* (Roewer), 22. Carapace, dorsal aspect, 23. Carapace, lateral aspect, 24. Chelicera, ventral aspect, 25. Palp, dorso-lateral, aspect, 26. Tarsus of leg III, lateral aspect, 27. Ovipositor, ventral aspect, 28. Ovipositor (enlarged), ventral aspect

Table 3: Measurements in mm for the palp and legs I-IV of *Neassamia aborensis*

	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Palp	0.60	1.87	1.10	0.80	1.30		05.67
Legs I	0.60	2.12	0.80	1.93	2.64	1.43	09.82
II	0.60	4.29	0.88	3.96	4.73	1.98	16.14
III	0.60	2.53	0.88	1.67	3.41	1.76	10.25
IV	0.80	5.06	1.21	2.20	5.06	1.32	15.65

obsolete present and inner surface with only a few tuberculate spines. Tarsus shorter than metatarsus, curved and sharply pointed into claw (Fig. 25). Legs I-IV: coxa I ventrally covered with bunch of tuberculate granules on distal portions, anterior margin with 8-9 tuberculate granules and middle rows of 9-10 granules, coxa II anterior margins with 11 granules, coxa III with 10-11 granules on outer margins, coxa IV with 7-8 weak granules on anterior margins. Leg formula 2431.

Measurements: Cephalothorax 3.8 mm long.

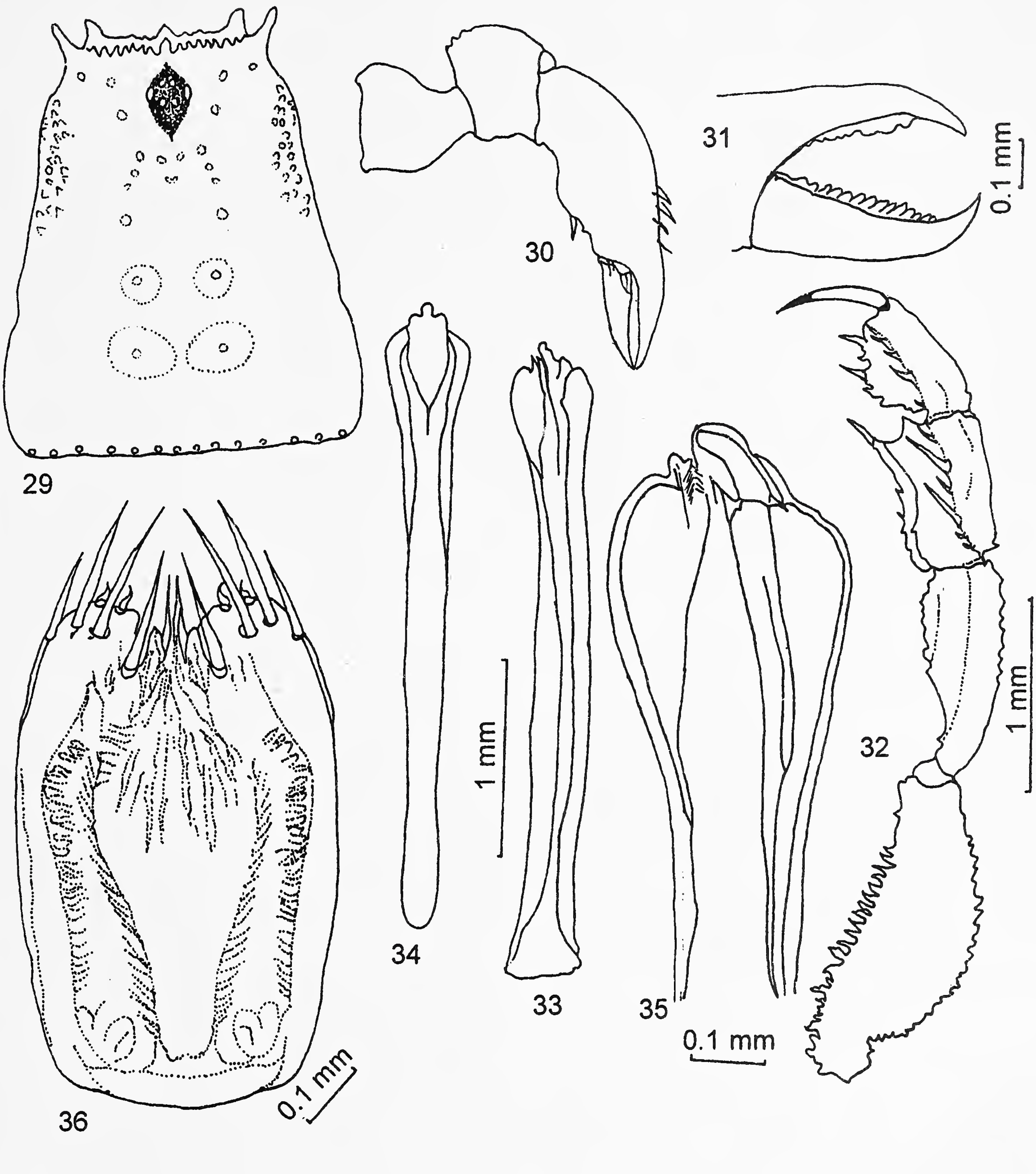
Type-Data: Lectotypes 2♀♀ **Locality**: Upper Rotung, Abor Hills, NEFA (now Arunachal Pradesh), Abor expedition 31.xii.1911, det. Roewer, ZSI, Type No. 1312/17; 1E, **Locality**: Sirpo, Nr. Parjing, 1500' Abor Hills, NEFA (now Arunachal Pradesh), Coll. M. De Courey, March, 1912, det. Roewer, ZSI, Type No. 1307/17.

4. *Anassamia rufa* (Roewer)
(Figs 29-36)

1927. *Assamia rufa*: Roewer, *Weutn. Weber I,* 26(2): 359.

1935. *Anassamia rufa*: Roewer, *Veröff. dtsch. Kolonial-u. Übersee-Mus.* 1(1): 36.

Cotype: 1 ♀ Cephalothorax closely and finely granular but granules congregated in furrows and margins, some tuberculate granules present along lateral submarginal portions, anterior margin with a short median and two lateral tuberculate spines, with submarginal tuberculate granular ridge, median tubercle spiny between anterior median marginal spine and ocular tubercle, ocular tubercle wider than long and as high, bearing an anterior and a posterior pair of small tuberculate spines, with a pair of eyes, posterior median furrow distinct, a few tuberculate granules between furrow and ocular tubercle, 3 pairs of median spines placed on elevated portion at distance from anterior margin I: 3.52, II: 3.85 & III: 4.18 and separated from each other by I: 1.32, II: 0.83 & III: 0.72 respectively, lateral margins smooth and posterior margin evenly granular (Fig. 29). Tergites and sternites finely granular with posterior granular margins. Female ovipositor short, swollen and spinous as in Fig. 36, and male penis as in Figs 33-35. Chelicera three segmented, 1st segment bulging dorsally on anterior base of immovable fingers on outer surface, 3 setae on inner surface, 4-5 at the base of movable finger, 6-7 small and stout spines on inner masal surface, movable fingers armed with serrula of 11 minute teeth on inner margins, immovable finger armed with series of triangular, pointed cutting teeth (Fig. 31). Palp with tubular trochanter, armed with a few tuberculate granules on distal ventral portion, femur laterally compressed, slightly inwardly bent, carinated, exterior carinae armed with 13-14 delicately crenulate tubercles, interior carinae crenulate but weak distally. Patella shorter than femur, broad distally, carinated, carinae sparsely crenulated on exterior portions, inner carinae armed with 4-5 short spines. Tibia shorter than patella, expanded on inner portions, carinated, expanded edges with distal apophysis and armed with a strong spine each, edges carinated and provided with a few spines, inner margins with 2 spines. Metatarsus shorter than tibia, also expanded on



Figs 29-36: *Anassamia rufa* (Roewer), 29. Carapace, dorsal aspect, 30. Chelicera (3 segments), lateral aspect, 31. Movable and immovable fingers of chelicera, lateral aspect, 32. Palp, dorso-lateral aspect, 33. Penis, ventral aspect, 34. Penis (distal portion enlarged) ventral aspect, 35. Penis (distal portion enlarged) ventral aspect, 36. Ovipositor, ventral aspect

Table 4: Measurements in mm for the palp and legs I-IV of *Anassamia rufa*

	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Palp	0.77	1.98	1.21	0.99	1.38		06.33
Legs I	0.55	2.42	0.88	3.19	2.75	1.54	11.33
II	0.55	3.52	0.21	4.29	4.95	2.75	14.57
III	0.66	3.85	1.32	2.42	4.18	1.98	14.41
IV	0.77	5.28	1.32	3.41	5.94	1.98	18.70

outer sides, almost rounded, armed with 2 long and a few short spines, carinae weakly crenulate. Tarsal spine short, curved and acutely pointed. Legs I-IV: Coxa I anterior margin with 6 dentiform granules, posterior margin with 12-13 granules, but only 6-7 distal granules dentiform, ventral median portion covered with row of 10-11 granules but only 5-6 distal granules dentiform; Coxa II with 9-10 dentiform granules only on proximal and middle portions; Coxa III with 4-5 dentiform granules on anterior margin and 7-8 on posterior margin; Coxa IV broader, with a few tuberculate granules on anterior margin and only 2 smooth, flat granules on inner margin; Leg formula 1324.

Measurements: Cephalothorax 5.28 mm long.

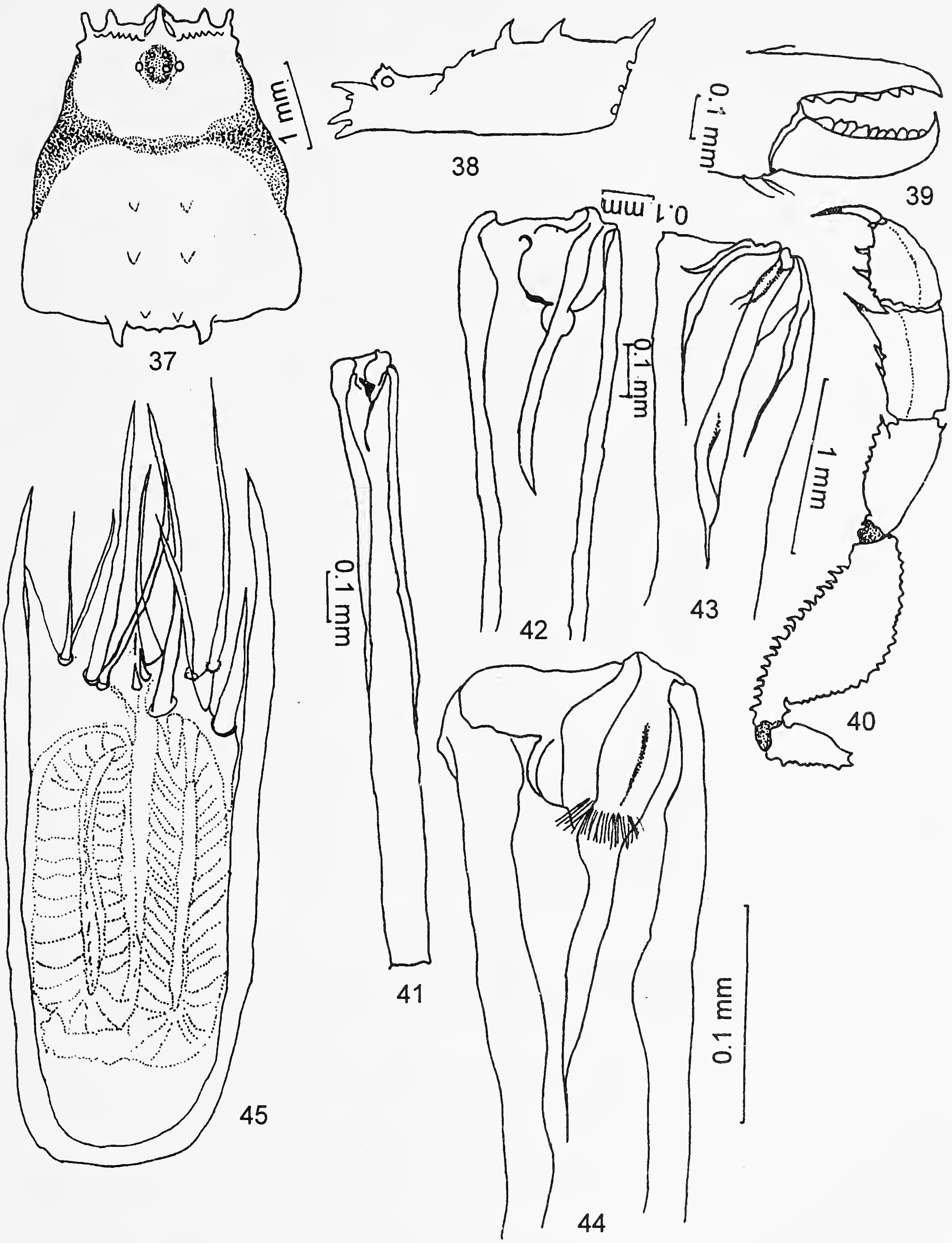
Type-Data: **Lectotype** 4♀, 1♂, **Locality**: Birbhum district (now in Assam), det. Roewer, 1924, No. 5583, Indian Museum Type Regn No. 1054/18 (now ZSI).

5. *Assamia punctata* Roewer

(Figs 37-45)

1924. *Assamia punctata*: Roewer ??

Lectotype: 1♀, Cephalothorax almost smooth except a few large granules interior to anterior sub-marginal ridge of 7-8 tuberculate granules, with a median upright spine, anterior margin with a median and two lateral spines, both median and lateral equal in length and pointed, ocular tubercle wider than long, and as wide as high, with two pair of spines, anterior pair small and obsolete, posterior pair short, stumpy, but pointed, a pair of median eyes, black at the base, median furrow distinct in middle portion, posterior portion with 3 upright spines, backwardly directed, and placed at distance of 2.3, 3.0 & 4.2 respectively from anterior margin, 3rd placed on posterior margin, few granules tuberculate (Figs 37 & 38). Tergites almost smooth to weakly but finely granular, posterior margins granular, weakly to poorly tuberculate; sternites smooth except sternite I with 3-4 tuberculate granules on lateral portions. Female ovipositor as in Fig. 45, male penis as in Figs 41 (ventral view), 42 & 43 (ventral view, only distal portion) and 44 (ventral, only distal portion enlarged). Chelicera three segmented, 1st segment bulging on dorsal anterior portions, granular on inner portions, basal segment twice as long as wide, ventral surface with 4+3 spinulate spines, 4 at the base of immovable finger, and 3 at the base of movable finger towards ventral side, 1 seta at the base towards dorsal side, movable finger armed with serrula of 9-10 small teeth in series on inner margin, immovable finger provided with a series of 6-7 small, pointed, cutting teeth on inner margin (Fig. 39). Palp with trochanter tubular but broad distally with 1-2 tuberculate granules on ventral distal end. Femur laterally compressed, flatter in middle portion and curved inwardly, carinated, exterior carinae with 14 dentiform granules, interior carinae weakly crenulate. Patella shorter than femur, expanded distally, concave, carinated, weakly crenulate, inner carinae ending in short, pointed spines. Tibia shorter than patella, almost quadrangular, expanded laterally on ventrolateral margin, carinated and outer ventral carinae provided with few small spines and strong



Figs 37-45: *Assamia punctata* Roewer, 37. Carapace, dorsal aspect, 38. Carapace, lateral aspect, 39. Movable & immovable fingers of chelicera, lateral aspect, 40. Palp, dorso-lateral aspect, 41. Penis, ventral aspect, 42. Penis (distal portion enlarged) dorsal aspect, 43. Penis (distal portion enlarged) ventral aspect, 44. Penis (distal portion further enlarged) ventral aspect, 45. Ovipositor, ventral aspect

Table 5: Measurements in mm for the palp and legs I-IV of *Assamia punctata*

	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Palp	0.44	1.54	0.88	0.87	1.10		04.83
Leg I	0.44	1.98	0.66	1.43	2.20	1.21	07.92
II	0.55	3.30	0.99	3.08	3.96	2.31	14.19
III	0.55	2.31	0.88	1.76	2.86	1.32	09.68
IV	0.55	2.86	1.10	2.42	2.31	1.65	10.89

apophysis on distal portion, armed with elongated spines and supported anteriorly with smaller spines (Fig. 40), inner ventral margin weakly carinated with 2 elongated spines and a few short spines. Metatarsus shorter than tibia, flat but concave on inner surfaces, outer margin expanded with 2 strong and a few small spines, inner ventral marginal carinae smooth and obsolete but provided with 1 pair of elongate spines. Tarsus shorter than metatarsus, strongly spined, bent inwardly and acutely pointed. Legs I-IV: coxa I ventrally covered with tuberculate granules arranged in two rows, middle row with 10 strongly tuberculate granules on distal portion, anterior margins with 6-7 tuberculate granules; coxa II sparsely granular, 6-7 tuberculate granules on anterior margin, 9-10 tuberculate granules on inner margins, coxa III sparsely granular, 6-7 tuberculate granules on anterior margin and 11-12 on posterior margin, coxa IV granular distally, a few granules present on posterior distal margin; Leg formula 2431.

Measurements: Cephalothorax 4.29 mm long.

Type-Data: **Lectotype**: 1 ♀, 1 ♂, **Locality**: Third camp to Misty Hollow, Dawana Hills, 490-2400', Coll. F.H. Gravely, 22-30.xi.1911; det. Roewer, M. 1924, ZSI Type No. 1220/17.

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CLADOCERAN FAUNA OF MALDA DISTRICT, WEST BENGAL[1]

S.V.A. Chandrasekhar[2] and Tapas Chatterjee[3]

Key words: Cladocera, Taxonomy, Malda district, West Bengal

The paper deals with Cladocera from six ecological niches in Malda district of West Bengal. This study yielded 15 species of Cladocera from the district. It is the first systematic documentation of Cladocera from this district.

Introduction

The contributions of Gurney (1906, 1907), Brehm (1950,1953), Sharma (1978), Chandrasekhar (1998) Chatterjee and Chandrasekhar (1999), Venkataraman and Das (1993); Venkataraman *et al.* (2000) reported on cladoceran fauna from West Bengal. The present paper describes material collected from different ecological niches in Malda district, West Bengal. Although the present record of cladoceran fauna of West Bengal is 41 species, no literature on Malda district is available. As a result of this study, 15 species of Cladocera referable to 11 genera from 4 families are recorded. This is the first authentic document on this group from the district.

Malda district (25° 03' N and 88° 09' E) is the gateway to northern West Bengal and three major rivers, Ganga, Mahananda and Tangan, pass through the district. It is a low-lying area, prone to frequent floods. Mango and rice cultivation, sericulture and pisciculture are the three major economic activities of the district.

Material and Methods

Material was collected by the second author from a number of water bodies by towing plankton net (No. 25) in its sublittoral regions. The catch received in a plastic bottle at the end of a net was transferred to plastic containers and preserved in 4% formal. The material was identified with the help of keys in Michael and Sharma (1988), and Battish (1992). Ocular micrometre were used to take measurements.

The list of localities with the period of collection is given in Table 1. Specimens have been deposited in the Freshwater Biological Station, Zoological Survey of India, Hyderabad.

SYSTEMATIC ACCOUNT

Phylum: Arthropoda
Class: Crustacea
Sub class: Branchiopoda
Order: Cladocera
Family: Daphniidae

Scapholebris kingi Sars, 1903

Material examined: Female; length 0.58 mm, width 0.37 mm; MRDM.

Description: Carapace more or less quadrate, head depressed, rectangular, with posteroventral corner produced into a spine; posteroventral margin of valves almost straight, ventral margin ciliated; anterior region of head almost rounded, ventral margin concave; large eye, short and blunt rostrum; small antennules; post abdomen short and broad, rounded at posterior end with 5-6 anal spine.

Distribution: INDIA: Assam, Bihar, Kashmir, Nilgiri hills, Rajasthan, Meghalaya, Tamil Nadu and West Bengal. EXTRALIMITAL: Africa, Australia, North America, Sri Lanka, Germany, China, Thailand, Indonesia.

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Table 1: Sampling site and period of collection of Cladocera from Malda district of West Bengal

Sl. No.	Localities	Abbreviation used	Period of collection
1.	Mahananda river at Aiho village near Jadavnagar	MRAV	June, 1998
2.	Mahananda river and its associated ditches near Malda town bridge	MRDM	June, 1998
3.	Flood affected roadside canal at Chandipur	RSCC	October, 1999
4.	A stagnant water body under Bhavanipur bridges near Chanchal	SWBCH	October, 1999
5.	A flood affected pond at Aiho village near Namotola	PAVN	October, 1999
6.	Malakar pond at Aiho village	MPAV	October, 1999

Simocephalus exspinosus (Koch, 1841)

Material examined: Female, length 1.0 mm, width 0.7 mm; MPAV.

Description: Carapace oval; dorsal margin almost straight, but forming curve before joining the posterior protuberance; posterior part of the dorsal margin distinctly denticulate, head small and triangular; eye situated at vertex. Postabdomen broad, slightly narrow apically; 10-12 anal spines; claw long with a distinct pecten.

Distribution: INDIA: Meghalaya, Karnataka and West Bengal. EXTRALIMITAL: Cosmopolitan.

Family: Moinidae

Moina micrura Kurz, 1874

Material examined: Female, length 0.3 mm, width 0.18 mm; PAVN.

Description: Head large, rounded anteriorly; small spindle-shaped antennule with distal sensory hairs; eye large, valves oval shaped, reticulate with rounded posterior margin; postabdomen short, with a few thick, ciliated, anal denticles; with long and curved claw, 3-7 teeth present at ventral base of claw; concave margin of claw with fine setae.

Distribution: INDIA: West Bengal, Nilgiri hills, Bihar, Karnataka, Punjab, Haryana, Rajasthan and Tamil Nadu. EXTRALIMITAL: Africa, Syria, Russia, France, Philippines.

Family: Macrothricidae

Echinisca triserialis (Brady, 1886)

Material examined: Female, length 0.6 mm, width 0.45 mm, MRAV.

Description: Body roughly oval in shape, dorsal margin slightly arched compared to ventral margin, with serrations; antennule cylindrical and widened distally; head and eye large, postabdomen large, moderately broad, bilobed; short, curved claw.

Distribution: INDIA: West Bengal, Rajasthan Bihar, Meghalaya and Kerala. EXTRALIMITAL: Australia, Philippines, Sri Lanka, Morocco, Russia, France.

Family: Chydoridae

Subfamily: Chydorinae

Chydorus sphaericus (O.F. Muller, 1776)

Material examined: Female; length 0.53 mm, width 0.48 mm; RSCC.

Description: Body spherical; valves rounded at posterodorsal and posteroventral corners, with pentagonal reticulations; rostrum pointed; postabdomen short, with 7-10 denticles; preanal corner projecting, lateral setae in several groups and arranged in single row; claw with two basal spines and setae on the concave margin.

Distribution: INDIA: West Bengal, Bihar, Kashmir, Ladakh, Nilgiri hills, Punjab and Meghalaya. EXTRALIMITAL: Cosmopolitan.

Chydorus ventricosus Daday, 1898

Material examined: Female; length 0.4 mm, width 0.3 mm; MRDM.

Description: Body almost oval, posterodorsal and posteroventral corners of valves rounded, valves with polygons enclosing pigment patches and dots; long rostrum with pointed, V-shaped rostrum notch at the tip; postabdomen elongated, slightly tapering distally and distinct preanal corner with 9-10 marginal spines and 4-7

lateral group of setules; claw with long slender basal spine and setae on concave margin.

Distribution: INDIA: Nilgiri hills, Gujarat, Rajasthan, Tamil Nadu, Kerala, Maharashtra and West Bengal. EXTRALIMITAL: Sri Lanka, China, Java, East Africa.

Dunhevedia crassa crassa King, 1853.

Material examined: Female; length 0.5 mm, width 0.45 mm; MPAV.

Description: Body oval; posteroventral corner of valves with denticle; ventral margin with feathered setae, middle seta longest; postabdomen oval with 15-18 spines; claw with basal spine.

Distribution: INDIA: West Bengal, Gujarat, Rajasthan, Tamil Nadu and Kerala. EXTRALIMITAL: Holarctic region, Ethiopia, Indo-Malayan, Russia and Australian region.

Subfamily: Aloninae

Alona davidi davidi Richard, 1895

Material examined: Male; length 0.9 mm, width 0.7 mm MRDM.

Description: Body oval; valves with polygons; posterodorsal and posteroventral corners of valves rounded; antennules not reaching apex of rostrum; postabdomen narrowing distally; preanal margin slightly shorter than postanal margin; claw with one basal spine; setae present on proximal part of concave margin.

Distribution: INDIA: West Bengal. EXTRALIMITAL: Ethiopian region, Haiti.

Alona davidi punctata (Daday, 1898)

Material examined: Female; length 0.6 mm, width 0.5 mm; MRAV.

Description: Body suboval; dorsal margin of head forming smooth curve with dorsal margin of valve; ventral margin of valve projecting in middle, with feathered setae passing on the posteroventral corner into a row of short setules, which continue on posterior margin; rostrum blunt, plate of labrum rounded; postabdomen widest in the middle, tapering distally, with 10-12 groups of lateral anal spines and groups of fine setae, claw with one basal spine and setae on concave margin.

Distribution: INDIA: West Bengal and Tamil Nadu. EXTRALIMITAL: Ethiopian and Australian region, Argentina.

Alona pulchella King, 1853

Material examined: Female; length 0. 35 mm, width 0.22 mm; MRDM.

Description: Body almost quadrangular in shape; posterodorsal and posteroventral corners of valves rounded; rostrum blunt, antennules not reaching apex of rostrum; keel of labrum posteriorly curved; postabdomen with almost straight margins, lateral setae in groups, distal seta longest in each group - basal spine present on claw, setae absent on concave margin of claw.

Distribution: INDIA: Gujarat, West Bengal and Tamil Nadu. EXTRALIMITAL: Australia, Sri Lanka, Philippines, Russia.

Leydigia acanthocercoides (Fischer, 1854)

Material examined: Female; length 0.54 mm, width 0.5 mm; MRAV.

Description: Body almost oval and compressed; valves with longitudinal lines; head shield with rounded posterior margin; rostrum short, blunt, directed slightly ventrally; ocellus larger than eye; postabdomen broadly rounded and margin concave with large lateral groups with two setae in each; claw without basal spine.

Distribution: INDIA: West Bengal, Rajasthan and Gujarat. EXTRALIMITAL: Ethiopian, Indo-Malayan, Neotropical and Europian-Russian region.

Oxyurella singalensis (Daday, 1898)

Material examined: Male; length 0.52 mm, width 0.33 mm; MRDM.

Description: Valves with dots on ventral side, posterodorsal and posteroventral corner of valves rounded; postabdomen uniformly wide but slightly tapering distally; anal spines confined

to rounded dorsal end of postabdomen; first leg with a blunt hook; claw large with two basal spines, the large one some distance from base and the small one near the base.

Distribution: INDIA: West Bengal and Kerala. EXTRALIMITAL: Ethiopian, Indo-Malayan region, China.

Oxyurella tenuicaudis (Sars, 1862)

Material examined: Female; length 0.6 mm, width 0.44 mm; MRDM.

Description: Body oval, posteroventral corner rounded with row of spinules on inner side; rostrum blunt, directed ventrally, postabdomen narrowing distally, with 12-13 anal spines, of which distal one very large, a small spinule near claw.

Distribution: INDIA: West Bengal. EXTRALIMITAL: Holarctic region, European part of Russia.

Kurzia latissima (Kurz, 1875)

Material examined: Female; length 0.87 mm, width 0.68 mm; MRDM.

Description: Posterodorsal and posteroventral corners rounded; head and valves forming semicircular dorsal arch; rostrum long, antennules not reaching apex of rostrum; postabdomen long, narrow, slightly tapering distally, with 12 marginal anal spines; claw with basal spine, setae present on concave margin of claw.

Distribution: INDIA: West Bengal. EXTRALIMITAL: Holarctic, Neotropical region and European part of Russia.

Euryalona orientalis (Daday, 1898)

Material examined: Female; length 0.6 mm; width 0.46 mm; SWBCH.

Description: Body quadrangular, ventral margin with blunt process, ventral middle margin of valves with setae arising at some distance from margin; valves with concentric rows of weak dots at their margins; antennule reaching apex of rostrum; postabdomen narrow, slightly curved with about 20 anal denticles; basal spine present on claw; setae present on proximal half of concave margin of claw.

Distribution: INDIA: West Bengal and Tamil Nadu. EXTRALIMITAL: Indo-Malayan, Ethiopian and Neotropical region.

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We thank the Director, Zoological Survey of India (ZSI), Kolkata and Officer-in-charge, Freshwater Biological Station, ZSI, Hyderabad for facilities.

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NEW DESCRIPTIONS

A NEW SPECIES OF *AMBLYANTHUS* A. DC., FAMILY MYRSINACEAE, FROM ARUNACHAL PRADESH, INDIA[1]

(*With one text figure*)

G.S. Giri, S.K. Das and H.J. Chowdhery[2]

Key words: State Flora, Arunachal Pradesh, Myrsinaceae, new species, *Amblyanthus*

A new species of *Amblyanthus* from Arunachal Pradesh is described. The new species is closely allied to *A. multiflorus* Mez.

While studying herbarium specimens in connection with the State Flora of Arunachal Pradesh, the authors came across some interesting specimens collected from the Upper Subansiri district (S.K. Das). A critical study of the specimens and scrutiny of the literature revealed it to be a new species of the genus *Amblyanthus* A. DC. The same is described here with illustrations. A diagnostic key to the Indian species of the genus is also provided.

Amblyanthus obovatus Giri, Das et Chowdhery sp. nov. *A. multiflora* Mez, affinis sed distinguenda foliis obovatis vel obovato-oblongis, chartaceis, basi manifeste inaequalibus, apice acutis, petiolis longioribus (15-32 mm), inflorescentiis confertis paniculatim umbellatis, sepalis 1/3 connatis ad marginem fimbriatis, petalis 1/3 connatis ad marginem integris.

Holotypus lectus S.K. Das subnumero 3997A ad locum 10 km e Sippi *c.* 250 m, die 25.iv.1988, district Superior Subansiri (Arunachal Pradesh) India et positus in CAL; Isotypi 3997B et 3997C positus in ARUN.

Erect shrubs, 5-6 m tall, branches herbaceous, terete or slightly compressed when young, striate, gland-dotted younger parts ferruginously furfuraceous, older parts glabrous, bark thick, reddish. Leaves alternate, usually obovate, sometimes obovate-oblong, (22-)25-30 (-32) x (8-)9-11(-12.5) cm; base distinctly unequal, one side always 2-6 mm above the other, subrotund to subtruncate; apex acute; margin crenulate to undulate-crenate, recurved, with submarginal glands below crenatures, glands oblong or ellipsoid, 1-2 mm long, brownish; midrib depressed above, much raised beneath, lateral nerves opposite to alternate, 25-30(-35) on either side, nervules oblique, lateral nerves usually forked or branched near margin, ending in submarginal glands; lamina chartaceous, on drying turn blackish above, dark brown beneath, both surfaces glabrous, profusely dotted with brownish glands beneath, glands minute or conspicuous, round, oval or elliptic; petioles strong, deeply channelled, 1.5-3.5 cm long, glabrous. Inflorescence axillary, condensed, paniculately umbellate; peduncles 5-7 cm long, slightly compressed, ferruginously furfuraceous; bracts oblong, 5-8 x 2.5-3.5 mm, boat-shaped, apex acute, ferruginously furfuraceous and gland-dotted outside, glabrous inside. Flowers many, flower buds nearly globose, 2-3 mm diam; pedicels stout, angular, 0.5-1.5 mm long, ferruginously furfuraceous, brownish gland-dotted; bracteoles 2, adpressed at base of calyx, subulate. Calyx 1/3 connate at base, lobes 5, ovate to suborbicular, *c.* 1 x 1 mm, apex acute or obtuse, margin fringed, ferruginously furfuraceous, scattered gland-dotted outside, glabrous inside. Corolla pinkish, 1/3 connate at base, lobes 5, ovate to suborbicular, 1-1.5 x 1-1.5 mm, deeply concave, margin hyaline, entire, both surfaces glabrous, scattered gland-dotted, glands brownish. Stamens 5, included, filaments very

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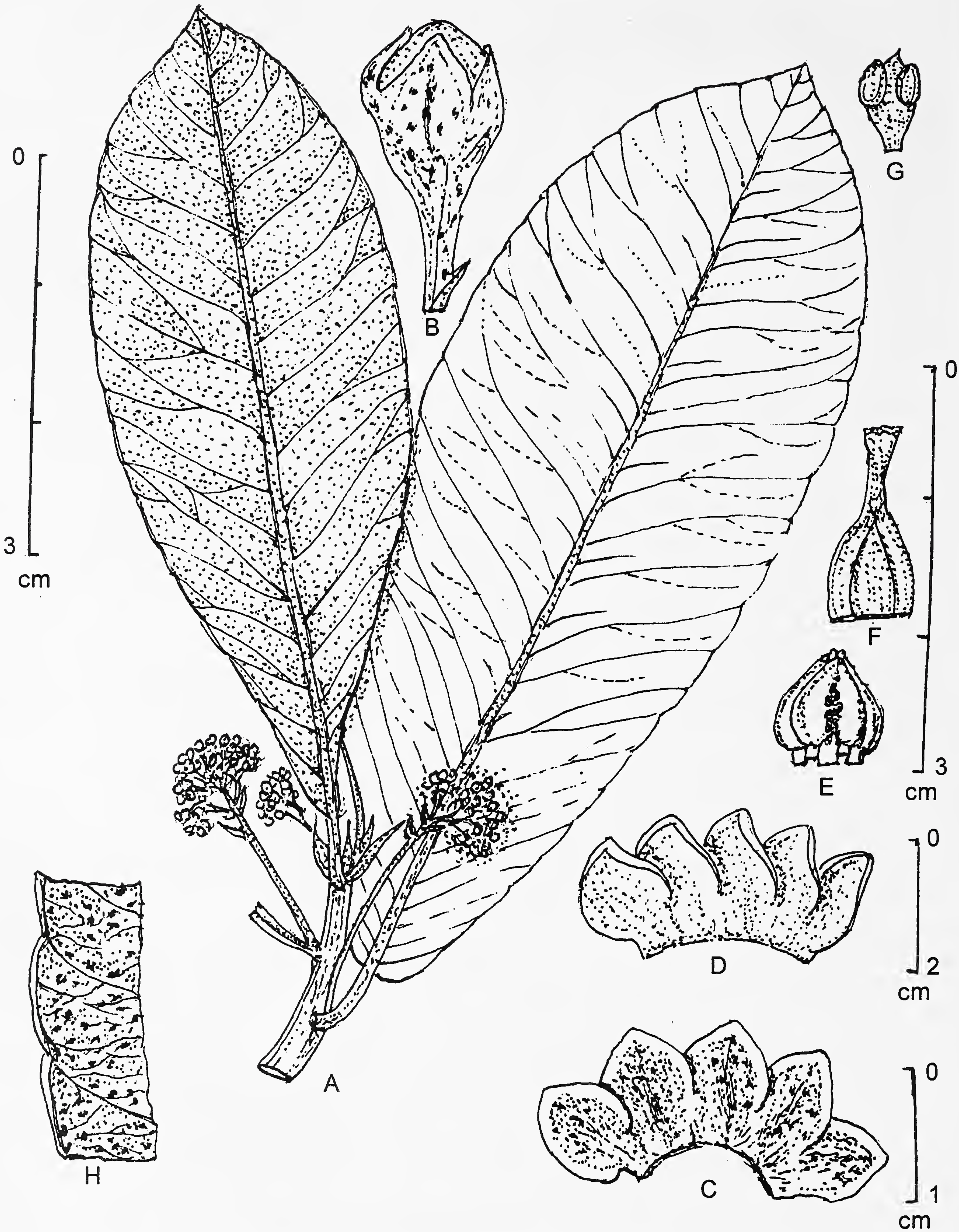

Fig. 1: *Amblyanthus obovatus* sp. nov., A. Habit; B. Flower bud; C. Calyx (split open); D. Corolla (split open); E. Stamens; F. Gynaecium; G. Ovules; H. Part of leaf margin

short, free, attached at very base of corolla; anthers connate along whole length of margin, broadly ovate, 0.75 x 0.5 mm, basifixed, dorsally punctate along connective. Ovary oval to ellipsoid, 0.5-0.75 mm long, glabrous, ovules 3-4, uniseriate; style columnar, *c.* 0.5 mm long, slightly dilated towards apex; stigma lobed. Fruit not seen.

Type: Arunachal Pradesh, Upper Subansiri district, 10 km away from Sippi, *c.* 250 m, 25.iv.1988, S.K. Das 3997A (Holotype CAL); 3997B & 3997C (Isotypes ARUN).

Fl.: April-May.

Habitat: In primary forests on thick humus along riverbank.

Note: *Amblyanthus obovatus* sp. nov. is allied to *A. multiflorus* Mez, but can be distinguished by obovate or obovate-oblong, chartaceous leaves with prominently unequal base and acute apex, longer petioles (15-32 mm long) inflorescence condensed, paniculately umbellate; sepals 1/3 connate with entire margin. Species of *Amblyanthus* A.DC. may be superficially confused with those of *Amblyanthopsis* Mez, mainly by habit and leaves. But the genus *Amblyanthopsis* Mez is characterised by free stamens, whereas the stamens of *Amblyanthus* A.DC. are connate, at least the anthers.

A diagnostic key to the Indian species of *Amblyanthus* A.DC. is given below.

Key to the Indian species of *Amblyanthus* A.DC.

1. Inflorescence terminal 2
— Inflorescence axillary 3
2. Leaves lanceolate, sepals connate up to middle .... *A. glandulosus*
— Leaves ovate-oblong, sepals connate up to 1/3 at base .... *A. praetervisus*
3. Leaves lanceolate, base equal, acute; sepals and petals 3/4 connate .... *A. multiflorus*
— Leaves obovate or obovate-oblong, base distinctly unequal subrounded to subtruncate; sepals and petals 1/3 connate .... *A. obovatus*

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■ ■ ■

A NEW SPECIES OF *PUNTIUS* HAMILTON (PISCES: CYPRINIDAE) FROM KALAKAD MUNDANTHURAI TIGER RESERVE, TAMIL NADU, INDIA[1]

(*With three text-figures*)

M. Arunachalam and J.A. Johnson[2]

Key words: Kalakad Mundanthurai Tiger Reserve, Tamiraparani river, Cyprinidae, *Puntius kannikattiensis* sp. nov.

Kalakad Mundanthurai Tiger Reserve (KMTR) is an important forest reserve for the origin of all the streams and rivers of the Tamiraparani system. Various streams and rivers of Tamiraparani river basin harbour several endangered and endemic fishes. Here we report a new species of the genus *Puntius* Hamilton from the Kannikatti region of KMTR. It was collected from the headwater streams of Tamiraparani river. *Puntius kannikattiensis* sp. nov. differs from the closely related species *Puntius fasciatus* in its morphometric characters and body colour pattern.

Introduction

Podigai hills, the core zone of Kalakad Mundanthurai Tiger Reserve (KMTR), have many streams and rivers, which form the major river Tamiraparani, a perennial east-flowing system in Tamil Nadu. The Tamiraparani has rich ichthyofauna, with a high degree of endemism. *Puntius arulius tambraparniei*, *Horalabiosa joshuai* (Silas 1953) and *Garra kalakadensis* (Rema Devi 1992) are endemic to this basin. Johnsingh and Vickram (1987) first documented the fish fauna of this sanctuary. About 70 species of fish, including several endangered large barbs like *Tor khudree*, *Hypselobarbus curmuca*, *H. kolus*, *H. dubius* and *H. dobsoni* are found in this region (Rema Devi *et al.* 1997, Arunachalam and Sankaranarayanan 1999). Because of its species richness and high degree of endemism, a detailed investigation on the fish habitats and ecological structure of fish assemblages in selected streams and rivers has been undertaken. As a part of the study, we collected good numbers of *Puntius* species from the different headwater streams of Tamiraparani river in the Kannikatti region (above Karaiyar reservoir), amongst which on close examination we found a new species of *Puntius* Hamilton. It differs from the closely related *P. fasciatus* by several morphometric characters.

Study Area

The Kannikatti region of KMTR is located west of Karaiyar reservoir (8° 35' 00"-8° 40' 30" N and 77° 15'-77° 25' E) in Tirunelveli district, Tamil Nadu (Fig. 1). It is an important core area for Project Tiger, and has thick and dense Moist Evergreen Forest. The eastern slope of this region is one of the important watershed areas, draining the perennial streams Ullar, Karaiyar, Kowthaliyar and Inchikuliyar. These tributaries join to form the major east-flowing river Tamiraparani. Inchikuli river and Ullar stream join to form the popular Banatheertham waterfall. The sampling site Ullar is located 5 km from the Banatheertham waterfall at 600 m above msl. It is a second order stream, with a maximum width of 10 m. The streambed comprises mainly of bedrock, large boulders and sand. There are 2 large pools and 3 riffles in a 100 m stretch. Water temperature was noted as 19 °C, and air temperature 21 °C. Both the river banks are occupied by deep, dense Semi-

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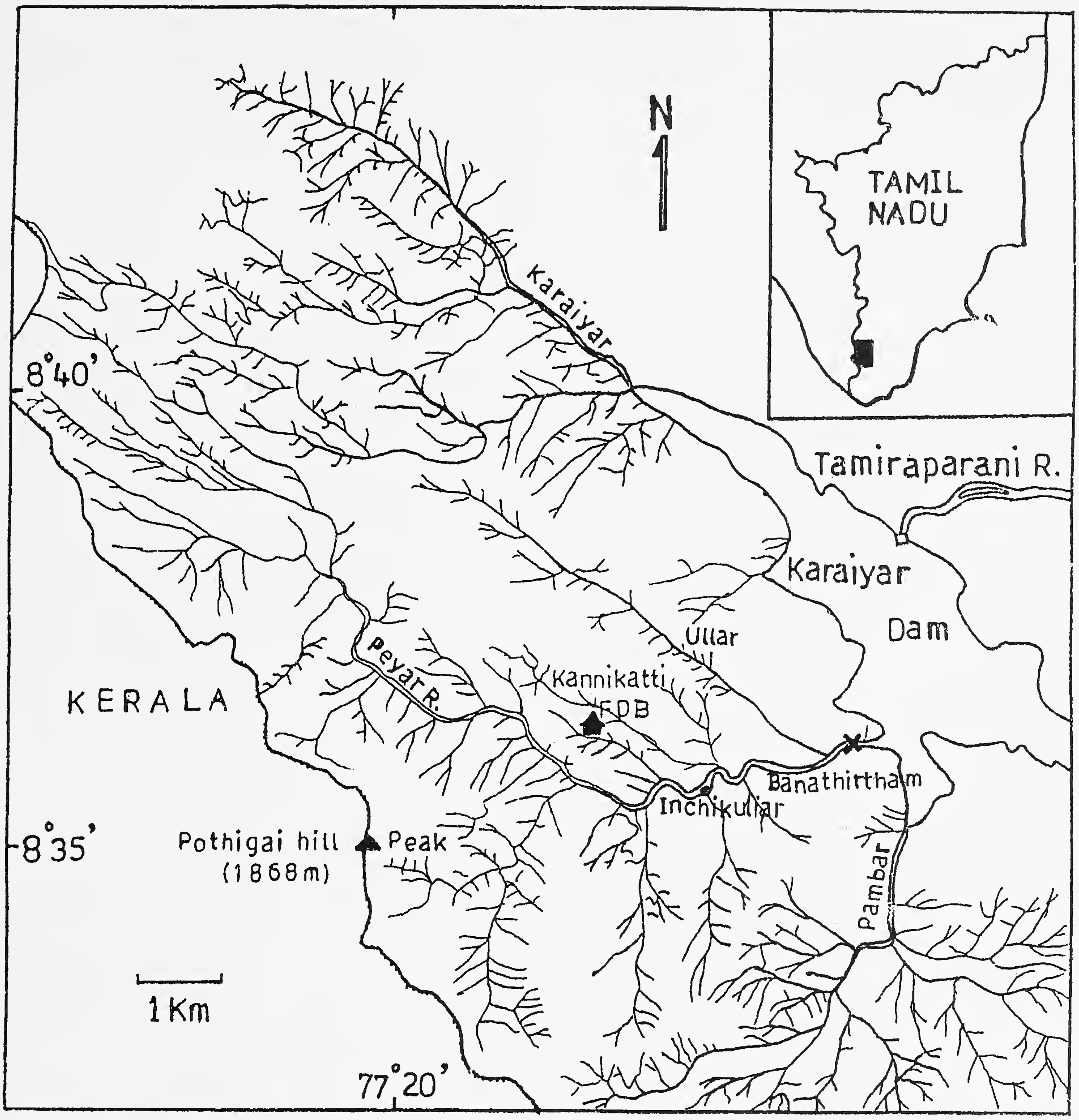

Fig. 1: Map of major streams/rivers in Kannikatti region of Kalakad Mundanthurai Tiger Reserve

Evergreen Forest, mostly old growth of overstorey trees (60-80%), the overhanging vegetation provides cover (80%) to fishes. The new species described here is also recorded from other tributaries like Inchikuliyar and Karaiyar of this region. *Puntius kannikattiensis* sp. nov. is a bottom dwelling fish, mostly found in the slow flowing streams and backwaters of channels. It hides under boulders, cobblestones and leaf litter in the stream.

Material and Methods

Fishes were collected by monofilamentous gill nets (8 and 12 mm mesh size), drag net and scoop net. All counts and measurements were made from specimens preserved in 10% formaline. Hubbs & Lagler (1958) were followed for morphometric measurements. The examined material *P. fasciatus* was collected from the streams of Wynaad, Kerala (part of Nilgiri

Biosphere Reserve), Kallar river, Sangilipuzha stream and Achankoil river in the southern Kerala part of the Western Ghats. All were preserved and deposited in the Sri Paramakalyani Centre for Environmental Sciences (SPKCES), Manonmaniam Sundaranar University, Alwarkurichi, Tamil Nadu. ANOVA was performed to distinguish the two closely related species using morphometric characters and multiple comparison was performed using TUKEY Test.

Abbreviations: SL standard length; HL head length; ED eye diameter; IOW inter orbital width; sd standard deviation; ZS1/SRS Zoological Survey of India/Southern Regional Station.

Puntius kannikattiensis sp. nov.

Holotype: ZSI/SRS F. 6147, 52.0 mm SL, ex. Ullar, a tributary of Tamiraparani river, above Karaiyar reservoir, Kannikatti region (Kalakad Mundanthurai Tiger Reserve), Tirunelveli district, Tamil Nadu, India. Altitude 600 m, 80° 35' 30" N and 77° 20' 35" E, Coll. M. Arunachalam and J.A. Johnson, 5.viii.1998. Holotype was deposited in the Zoological Survey of India, Southern Regional Station, Chennai.

Paratypes: ZSI/SRS F. 6148, 2 examples, 51-53 mm SL; SPKCES F. 4 (19 ex., 35-60 mm SL) same locality as holotype and Inchikuliyar, Karaiyar streams of Tamiraparani river, Coll. M. Arunachalam and J.A. Johnson, 5.viii.1998.

Materials examined: 23 specimens, 31-45 mm SL of *P. fasciatus*, from streams of Wynaad (type locality 10.viii.1997), Kallar river (4.i.1998), Achankoil river (12.x.1997) and Sangilipuzha (5.i.1998) in the Kerala part of Western Ghats, Coll. M. Arunachalam and J.A. Johnson.

Diagnosis: *Puntius kannikattiensis* is a small species reaching 60 mm SL. It is distinguishable from the closely related species *P. fasciatus* by the insertion of the dorsal fin nearer to caudal fin base than to tip of snout (vs. midway between tip of snout and caudal fin base in *P. fasciatus*), in having smaller eye (eye diameter 23.3-28.6% HL, vs. 29.0 - 33.3 %) and having little space between vent to origin of anal fin (vs. no space in *P. fasciatus*). It also differs from *P. fasciatus* in its body colour and markings. In adults, the entire body is blackish-brown; the juvenile has two black blotches, one below the dorsal fin and one oval blotch at caudal peduncle (blotches indistinct in adults) vs. pale yellow colour body with three black vertical bars in *P. fasciatus*.

Description: The general body shape and appearance are shown in Fig. 2. Morphometric data from holotype and paratypes of *P. kannikattiensis*, *P. fasciatus* and the statistical analysis are given in Tables 1 & 2.

Head and body compressed laterally, dorsal steeply arched and belly slightly rounded. Eyes placed dorsolaterally, visible from both dorsal and ventral aspects. Snout conical and nares placed closer to the eyes than to tip of the snout. Mouth inferior, arched, and lips fleshy, continuous at angle. Barbels two pairs, maxillary: first pair long, nearly twice the eye diameter. Dorsal fin origins above 7th scale of lateral line, inserted closer to caudal fin base than to tip of snout, with 2 simple and 8 branched rays, the last one branched to the base. Pectoral fin with 1 simple and 11 to 13 branched rays, and not reaching the pelvic fin. Pelvic fin originates just opposite the origin of dorsal fin, with 1 simple and 7 branched rays. Anal fin originates a little after the vent, with 2 simple and 5 branched rays, last one branched to the base. Caudal fin forked, with 9+8 branched rays. Lateral line complete with 20-22 scales. Predorsal scales 7, preanal scales 16 and circumpeduncular scales 12. Transverse scale count between lateral line to dorsal fin origin and pelvic fin origin is ½ 3 +1+2 ½.

Coloration: Live specimens are blackish-brown overall. Head and dorsal up to lateral line deep black. Ventral side brown. Body with two black round blotches: one below the dorsal fin extends just above the lateral line, another oval-shaped blotch at 14-16th lateral line scale of

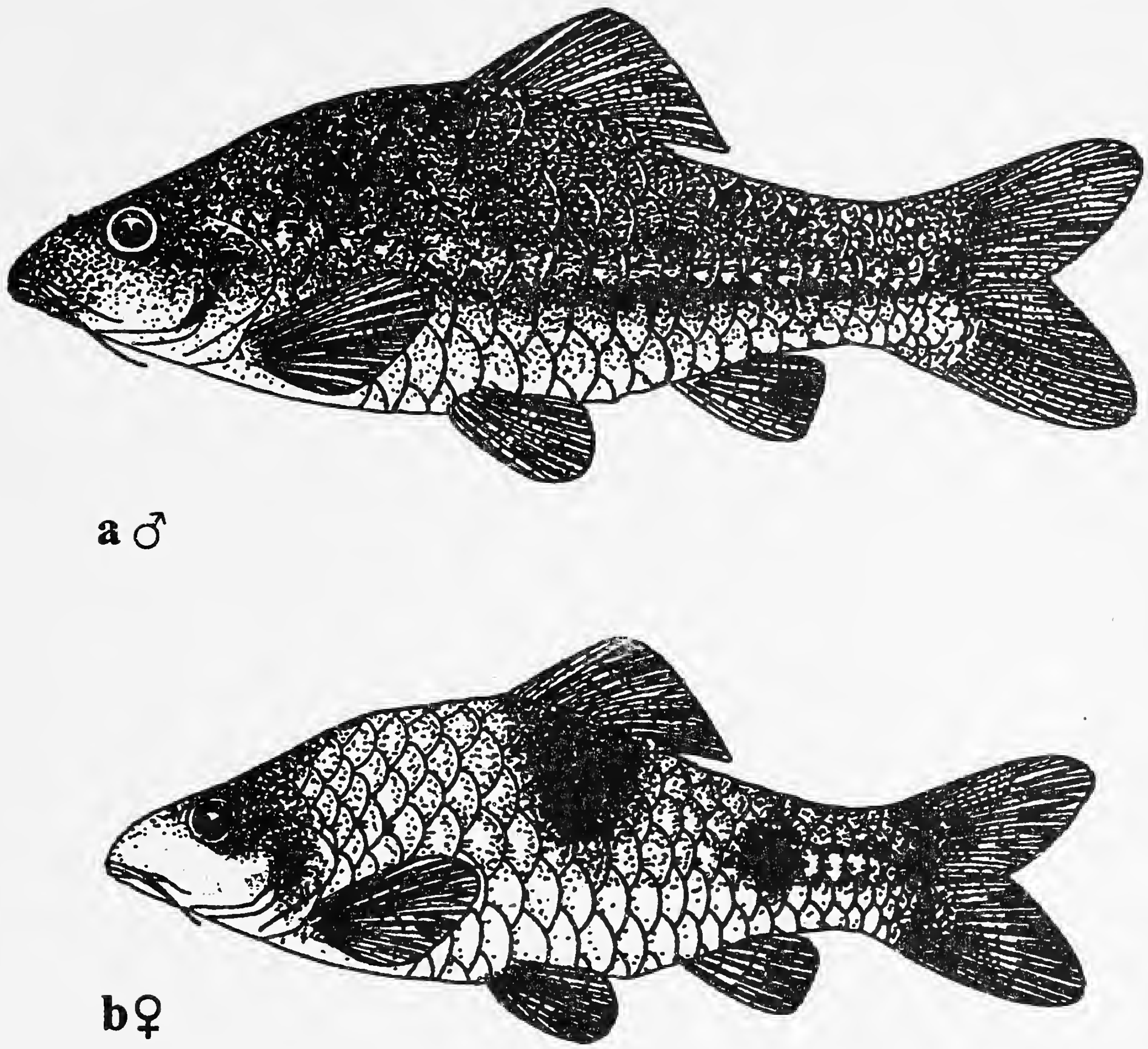

Fig. 2: Lateral view of a) *Puntius kannikattiensis*, 54 mm SL, Male, b) *P. kannikattiensis*, 47 mm SL, Female

caudal peduncle (more distinct in smaller specimens). Eyes deep red, all fins black. Preserved specimens in formalin: dorsal and lateral portion dark brown, ventral portion light brown, black blotches not clear (Fig. 2).

Sexual dimorphism: Males deep black, tubercles on front of snout, and extended laterally below the eyes, also on the lower jaw. Black blotches on the body not clear. Fins and lips deep black. In females: snout plain, no tubercles on snout or lower jaw. Lips white, fins pale yellow to dull white; entire body blackish-brown, blotches distinct.

Distribution: Ullar stream, Karaiyar stream and Inchikuli river of Tamiraparani, Kannikatti region, Kalakad Mundanthurai Tiger Reserve, Tirunelveli district, Tamil Nadu.

Etymology: The species is named after the type locality Kannikatti Reserve Forest region, Kalakad Mundanthurai Tiger Reserve, Tirunelveli district, Tamil Nadu.

Discussion

Puntius kannikattiensis sp. nov. differs from all *Puntius* species known so far. However, it is closely related to *Puntius arulius* and *P. fasciatus* (Jayaram 1999). There are more differences than similarities between these two species. *Puntius arulius* has a single pair of maxillary barbels (Silas 1953) while *P. kannikattiensis* has 2 pairs. It differs from *P. fasciatus* recorded from various streams in the Kerala part of Western Ghats in having smaller

Table 1: Morphometric measurments of *Puntius kannikattiensis* (Holotypes and paratypes) and *P. fasciatus*

Characters	*P. kannikattiensis* Holotype	Paratypes n = 23				*P. fasciatus* n = 23			
		Min.	Max.	Mean	s.d.	Min.	Max.	Mean	s.d.
% of Standard length									
Body width	39.3	34.5	42	38.71	1.95	32.4	37.8	36.07	1.23
Body depth	21.5	20.5	28.5	23.42	2.49	18.7	21.1	19.83	0.67
Head length	27.8	27.8	34.2	29.49	1.50	25.8	30.7	28.36	1.12
Predorsal Length	52.3	52.3	58.5	55.15	1.49	48.2	58.5	51.28	2.16
Length of caudal peduncle	14.8	13.5	18.2	15.66	1.52	16	18.9	17.55	0.80
Length of anal fin	19.6	15.7	19.6	17.29	1.52	17.25	21.4	18.86	1.05
Length of pelvic fin	19.6	16.6	21.0	18.87	1.12	18.9	21.6	20.12	0.78
Length of pectoral fin	21.6	18.2	25.0	20.2	1.65	20.2	22.8	21.54	0.82
Snout length	8.2	7	11.4	9.23	1.50	9.2	113.3	10.79	0.93
Eye diameter	8.0	7	8.6	7.63	0.46	8	9.4	8.48	0.36
% of head length									
Eye diameter	23.5	23.3	28.6	26.04	1.64	20	33.3	30.39	2.51
Snout length	29.4	25	39.3	31.31	4.94	35.2	42.8	38.7	2.32
Length of pectoral fin	70.6	62.5	78.6	70.73	3.67	70	80.9	75.21	3.07
Eye diameter/inter orbit width	71.4	58.3	75	67.89	5.02	62.5	80	70.31	6.37
Ht. Caudal peduncle/ Length of caudal peduncle	95.0	80	100	92.25	7.57	80	100	91.46	4.97

eye (25.9% HL vs. 30.8%) with less IOW (67.8% ED vs. 76.6) and larger body scales. The more distinct character is the insertion of dorsal fin closer to caudal fin base than to tip of the snout.

Table 2: Multiple comparison of characters by one-way Anova and mean values by Tukey Test (* = p<0.5)

Characters	Anova F-value	Tukey Test
Body width / SL	29.48	*
Body depth / SL	44.38	*
Head length	7.94	n.s
Predorsal Length / SL	47.14	*
Length of caudal peduncle / SL	27.42	*
Length of anal fin / SL	22.32	n.s
Length of pelvic fin / SL	18.57	n.s
Length of pectoral fin / SL	11.89	n.s
Snout length / SL	17.55	n.s
Eye diameter / SL	46.89	*
Eye diameter / HL	45.32	*
Snout length / HL	43.66	*
Length of pectoral fin / HL	19.44	n.s
Eye diameter / Inter orbit width	1.94	n.s
Ht. Caudal peduncle/ Length of caudal peduncle	0.17	n.s

n.s = not significant

In *P. faciatus*, the body bears 3 vertical black bars: the middle one is broad and extends to the ventral surface. In *P. kannikattiensis* there are two black blotches, one below the dorsal fin extended above the lateral line, and the other oval, at the caudal peduncle (more distinct in juveniles), vs. three black bars in *P. fasciatus*. Additionally, *P. kannikattiensis* has the largest size scales with broad focus region formed of number of radiating striae and more number of incomplete lateral striae (Fig. 3) vs. small scales, simple focus area without radiating striae (few radiating striae are found in scales from caudal peduncle region) and less number of complete lateral striae in *P. fasciatus*. Based on ANOVA, almost all the morphometric characters show differences except i) eye diameter/interorbital width and ii) height of caudal peduncle/length of caudal peduncle in *P. kannikattiensis* and *P. fasciatus*. Also significant results from Tukey test show that the two species are distinct for characters such as body depth, width, predorsal length, caudal peduncle length, eye diameter and

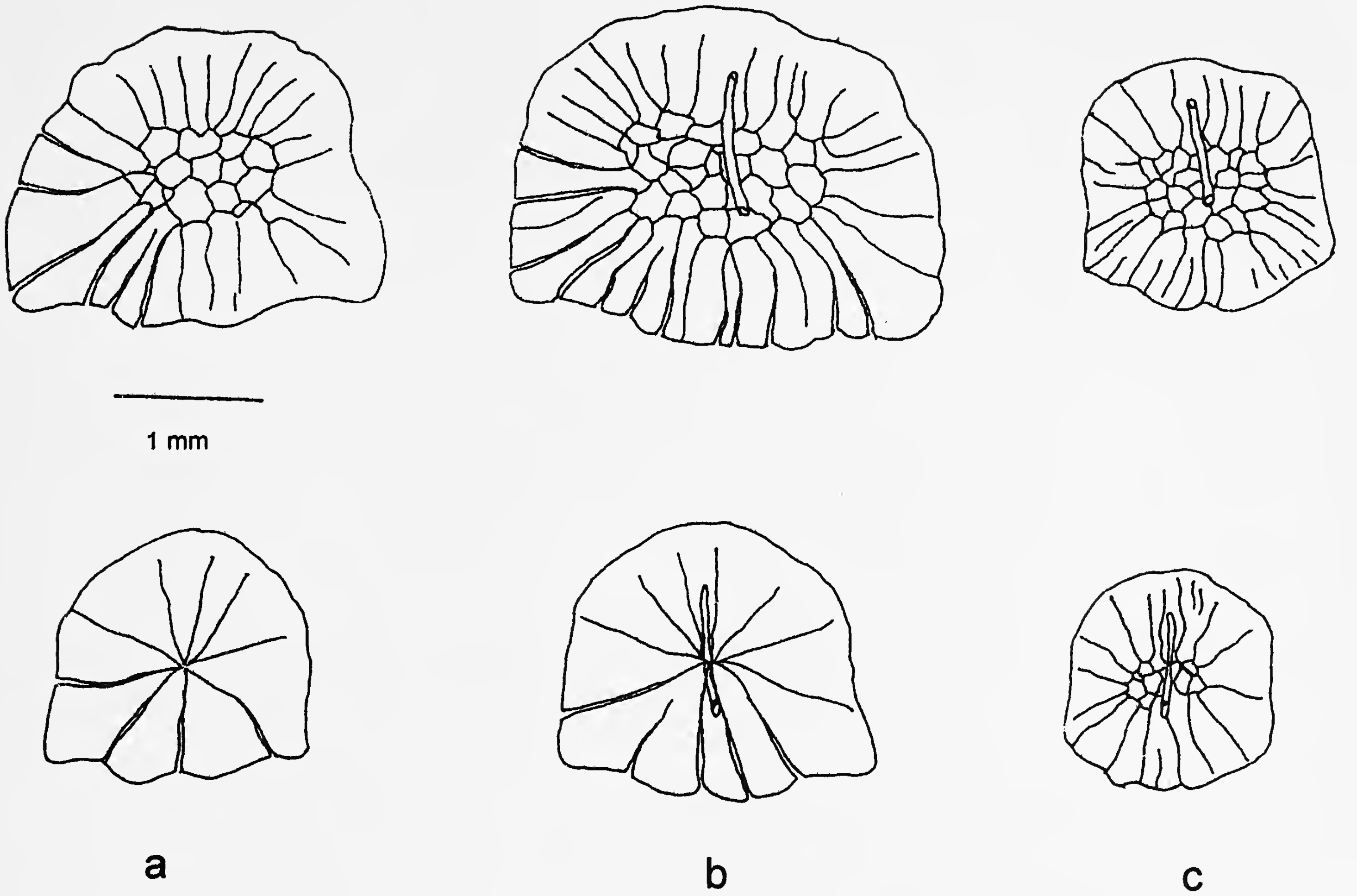

Fig. 3: a) Scales from behind opercule, b) Lateral line, c) caudal peduncle, *Puntius kannikattiensis* (above) and *P. fasciatus* (below)

snout length/SL and eye diameter and snout length/HL. The distribution of *P. fasciatus* is restricted mainly to west flowing streams/rivers of Kerala (except the east flowing ones of Nilgiri Biosphere Reserve, Jayaram 1991, 1999). Therefore the occurrence of this new species from an east flowing river of southern Tamil Nadu is of special interest.

Acknowledgements

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■ ■ ■

TWO NEW SPECIES OF PUNTIID FISH FROM THE YU RIVER SYSTEM OF MANIPUR[1]

(*With two text-figures*)

LAIFRAKPAM ARUNKUMAR[2,3] AND HIJAM TOMBI SINGH[2]

Key words: *Puntius yuensis*, *Puntius meingangbii*, Yu river system, Manipur

Two new puntiid species namely, *Puntius yuensis* and *Puntius meingangbii* are described from the Yu River system of Manipur. These species belong to the *puntio* group in having no barbels, twenty to twenty-four lateral line scales and nine predorsal scales.

P. yuensis is very similar to *P. puntio* but easily distinguishable by its serrated simple dorsal ray, incomplete lateral line scale pores, distinct yellow colour at the caudal peduncle, meristic and morphometric characters.

P. meingangbii differs from its nearest species *P. phutunio* and *P. gelius* by the two distinct black bands on the lateral sides of the body, distinct red coloration on the flank of the body and caudal fin, serrated unbranched dorsal ray, dorsal fin with three black bands and eight prepelvic scales.

INTRODUCTION

Manipur is a northeastern state surrounded by hills and with a distinct geographical entity. Its drainage system can be divided into three river systems, the Barak river system, the Manipur river system and the Yu river system. Hora (1921) wrote that the interest in the ichthyofauna of Manipur lies in the fact that the State is drained by two distinct drainages: the western half, by the Barak-Brahmaputra drainage and the central and the eastern half, by the Chindwin drainage. The Barak-Brahmaputra drainage of Manipur is represented by the Barak river system, which drains the western part of the State and finally enters the Brahmaputra river system of India. The Chindwin drainage of Manipur is represented by the Manipur river system and the Yu river system, which drains the central and eastern part of the State respectively, both finally entering the Chindwin-Irrawady river system of Burma (Myanmar). Eastern parts of the State covered by the Yu river system and its neighbouring areas of Myanmar were also known as the Chindwin of Meaner.

The Puntiid fishes of the genus *Puntius* Hamilton are widely distributed in Manipur as reported by several workers: Hora (1921) reported six species from Manipur. Menon (1952, 1954) mentioned nineteen species of fishes including *P. clavatus*, *P. conchonius*, *P. phutunio*, *P. sarana* and *P. ticto,* which were collected from the central valley and its surrounding hills. Datta and Laishram (1984) reported nine species of *Puntius* from Manipur. Vishwanath Singh and Tombi Singh (1986) described a new species *P. jayarami* from the Chakpi stream of Manipur and Chakpikarong (24° 18' N, 93° 95' E), 80 km south of Imphal in the Manipur river system of Manipur. Tombi Singh (1991) listed ten species of *Puntius* from this State. Talwar and Jhingran (1991) listed forty-six species of the puntiid group from India and its adjacent countries. Jayaram (1991) revised the genus *Puntius* Hamilton from the Indian region and listed fifty-three species under ten groups and fourteen complexes. Arunkumar and Tombi Singh (1997, 1998) reported 80 species of fishes including 7 species of *Puntius* and described a new species *Puntius morehensis* from the Yu river system of Manipur.

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During field surveys in Manipur in 1997 and 1998, specimens of two undescribed species were collected from the Yu river system, Manipur. They are herein described as new species namely, *Puntius yuensis* and *Puntius meingangbii.*

Material and Methods

Fishes were collected from the Yu river system of Manipur and their fresh colours were noted. The fishes were then preserved in 10% formalin and brought to the Fishery Laboratory of Manipur University. The specimens were identified from Jayaram (1991) and Talwar and Jhingran (1991). All the catalogued and uncatalogued *Puntius* species of the Manipur University of Museum of Fishes (MUMF) were studied in detail and compared with the new species collected recently. Finally, the identified specimens were catalogued and deposited in the Natural History Section of Manipur State Museum (NHSMSM) and the Manipur University Museum of fishes (MUMF).

Puntius yuensis sp. nov.

Fig. 1

Manipuri name: Ngakha-Hangampal

Holotype: MUMF 500/1A, 58.0 mm TL, 44.0 mm SL, Maklang river, 21 km from Moreh, Manipur, 24.ii.1997, Morning, 200 m above msl, Coll. L. Arunkumar.

Paratypes: MUMF 500/4A, 12 ex., 38.0-68.0 mm TL, 29.0-55.0 mm SL, Moreh Bazar, 110 km from Imphal, Manipur 24.ii.1997, Evening, 220 m above msl, Coll. L. Arunkumar. NHSMSM 5645.

Diagnosis: A *Puntius* species of the *puntio* group, distinguished by distinctive yellow coloration in the caudal peduncle and encircled by a single distinct black band. A distinct black blotch present at the lateral line scale inside this black band. Dorsal spine serrated posteriorly. Lateral line scale pores incomplete. 8 predorsal scales. 7 prepelvic scales and 14 preanal scales present.

Description: Branchiostegal rays 4; D. 2/7; P. 1/10-12; V. 1/6-7; A. 2/5; C. 17-19; L.l. 21-22; L.tr. 4½/2½. Body not fairly deep, dorsal profile slightly elevated and arched. Snout plain. Mouth subterminal. Lips thin and plain. Barbels absent. Dorsal fin inserted nearer to the base of caudal fin than to tip of snout. Lateral line incomplete with 6 to 9 pores. Pectoral and pelvic fins are more or less equal in length. Pelvic fin not touching the anal opening. Circumpeduncular scales 10 to 11. Lateral line to anal fin origin scales 2½. 8 predorsal scales are present. Width of mouth is more or less same as internasal distance. Last unbranched dorsal ray less than length of head and depth of body.

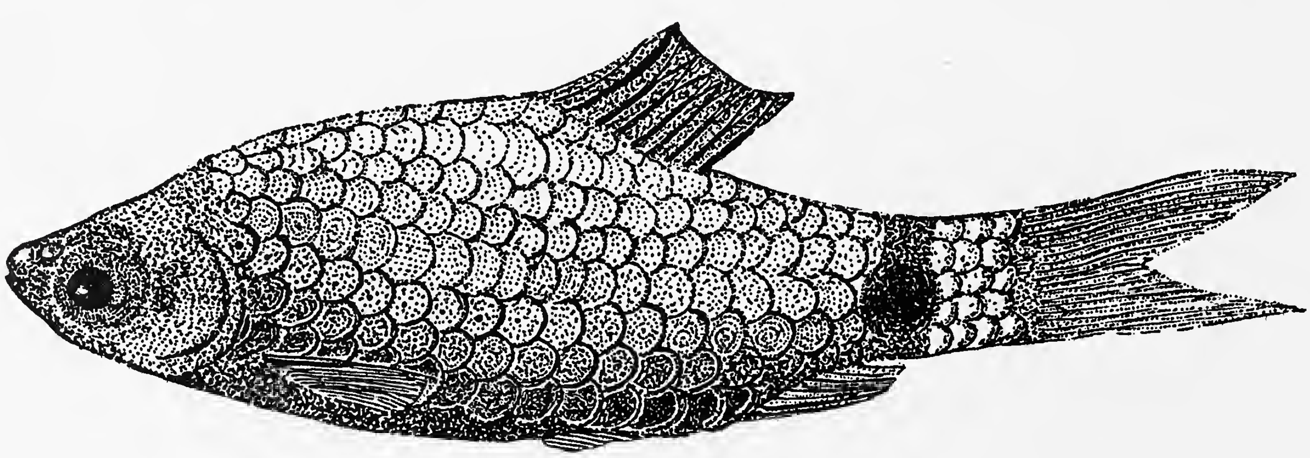

Fig. 1: *Puntius yuensis* sp. nov., paratype (MUMF 500/4A). 55 mm SL. Lateral View

Proportional measurements of holotype and paratypes (in parentheses): Length of head of occiput 15.52 (11.76-15.79) in total length. Length of caudal fin 31.84 (23.64-31.84), length of head at occiput 20.49 (14.55-20.70), predorsal length 54.64 (43.66-59.17), prepelvic length 50.00 (43.66-52.3), preanal length 78.18 (62.11-80.00), length up to preanal opening 72.99 (60.24-77.51) and width of body at dorsal fin origin 18.18 (13.79-18.18) in standard length.

Depth of head at occiput 90.98 (50.00-90.90), internasal distance 27.32 (12.5-27.32), height of caudal peduncle 54.64 (41.66-58.47), length of caudal peduncle 72.99 (58.47-72.09), length of dorsal fin base 52.08 (50.00-62.5), height of head at occiput 81.96 (66.66-81.96), length of snout 36.36 (20.83-36.36), length of pectoral fin 72.99 (66.66-75.18), width of head at nares 36.36 (25.00-36.36) and width of head at neck 63.69 (57.59-33.69) in length of head. Height of caudal peduncle 75.18 (71.42-87.71) in percentage of its length.

Colour: Body light yellowish. Dorsal light brown. Tip of anterior dorsal fin red. Caudal and anal fin light yellowish. Pectoral and ventral fin blackish. 18th and 19th scales of lateral line at caudal peduncle bear a black blotch with a black band.

Etymology: The type locality of the fish (Yu river system) gives the specific name of the fish.

Discussion: *P. yuensis* is known only from the Yu river system of Manipur at the lower zones of Maklang river and Lokchao river near Moreh. In the presence of a single band, it is most similar to *P. puntio*. However, *P. yuensis* differs from *P. puntio* in the presence of serrated unbranched dorsal ray, incomplete lateral line scale pores (6 to 9 vs. 23), less number of pectoral branched rays (10 to 12 vs. 15), distinct yellow coloration on the caudal peduncle region, length of head (17.66 to 23.09 vs. 25.00) in total length, and diameter of eye (86.95 to 100.00 vs. 133.33 to 200.00). The comparison of meristic and morphometric characters of *P. yuensis* and *P. puntio* is shown in Tables 1 and 2.

***Puntius meingangbii* sp. nov.**

Fig. 2

Manipuri name: Ngakha-Meingangbi

Holotype: MUMF 501/1A, 44 mm Total length, 34 mm Standard length. Moreh Bazar, Moreh 110 km from Imphal, Manipur, 24.ii.1997, evening, 220 m above msl. Coll. L. Arunkumar.

Paratypes: MUMF 501/2A, 11 ex., 39-45 mm TL, 30-35 mm SL, locality and collector same as Holotype. Uncat, MUMF, 14 ex; 41-43 mm TL, 30-33 mm SL, Manipur. NHSMSM 5646.

Diagnosis: A *Puntius* species of the *puntio* group, distinguished by the distinctive

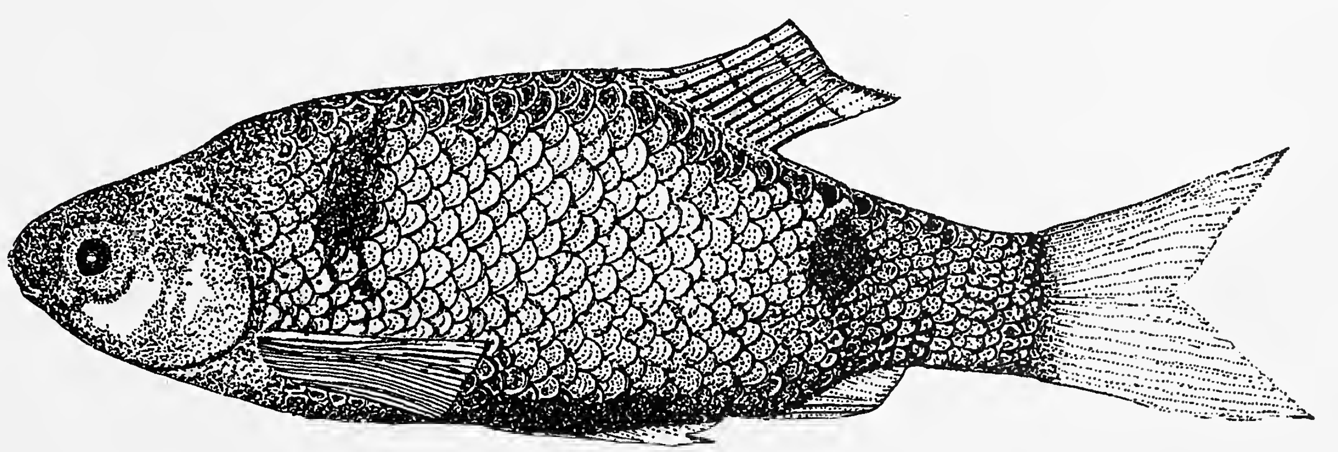

Fig. 2: *Puntius meingangbii* sp. nov., Paratype (MUMF 501/2A) 35 mm SL. Lateral View

Table 1: Comparison of selected meristic characters of *Puntius* based on literature sources

	P. yuensis sp. nov.		*P. puntio* (after Jayaram)	*P. meingangbii* sp. nov.		*P. phutunio* (after Jayaram)	*P. gelius* (after Jayaram)
	Holotype MUMF 500/1A	Paratypes MUMF 500/4A		Holotype MUMF 501/1A	Paratypes MUMF 501/2A		
Unbranched dorsal rays	2 (serrated)	2 (serrated)	3 (smooth)	(2 serrated)	2 (serrated)	2 to 3 (serrated)	2 (serrated)
Branched dorsal rays	7	7	8	8	8	8	8
Unbranched pectoral rays	1	1	-	1	1	-	-
Branched pectoral rays	11	10 to 12	15	15	15	15	14 to 15
Unbranched ventral rays	1	1	-	1	1	-	-
Branched ventral rays	6	6 to 7	8	7	7	8	8
Unbranched anal rays	2	2	2	2	2	3	3
Branched anal rays	5	5	5	5	5	5	5
Total caudal rays	19	17 to 19	21	18	18	19	19
Lateral line scales	22	21 to 22	23	23	21 to 23	20 to 23	23 to 24
Lateral line scale pores	6	8 to 9	23	6	6	3 to 4	4 to 6
Lateral line transverse scales	4½/2½	4½/2½	5½/2½	5½/3½	5½/3½	3½/4/3	4 to 5/3 to 4
Preanal scales	14	14	-	12	12	10 to 13	13
Predorsal scales	8	8	-	8	8	7 to 9	8
Prepelvic scales	7	7	-	8	8	5 to 6	6

Table 2: Comparison of selected morphometric characters of *Puntius* based on literature sources

	P. yuensis sp. nov.		*P. puntio* (after Jayaram)	*P. meingangbii* sp. nov.		*P. phutunio* (after Jayaram)	*P. gelius* (after Jayaram)
	Holotype MUMF 500/1A	Paratypes MUMF 500/4A		Holotype MUMF 501/1A	Paratypes MUMF 501/2A		
Unbranched dorsal rays	58	38-68	-	44	39-45	-	-
Standard length (mm)	44	29-55	-	34	30-35	21-38.5	20
In % of total length							
Length of head	18.97	17.66-23.09	25.00	22.72	20.00-23.09	-	-
Depth of body	25.90	22.07-27.62	30.00-33.33	27.32	25.64-26.66	-	-
In % of standard length							
Length of head	25.00	21.83-30.03	25.00	29.41	25.77-30.03	25.00-31.82	26.67-30.77
Depth of body	34.12	27.32-36.36	30.03-33.33	35.33	33.33-34.36	34.21-45.45	23.81-30.77
In % of length of head							
Height of head at occupit	81.96	66.66-81.96	-	68.24	66.66-68.96	84.61-100	66.67-100
Length of snout	36.36	20.83-36.36	-	25.00	22.22-27.27	28.57-33.33	33.33-40.00
Length of dorsal fin base	52.08	50.00-62.50	-	60.24	57.80-72.46	57.14-69.23	50.00
Width of mouth	22.22	20.00-25.00	-	22.22	15.01-22.22	21.00-28.57	25.00
Diameter of eye	36.36	25.00-36.36	25.00	25.00	22.22-27.77	28.57-35.45	33.33-50.00
In % of interorbital distance							
Diameter of eye	80.00	75.18-100	100	75.18	62.5-66.66	75.00-133	75.19-100
In % of length of snout							
Diameter of eye	100	86.95-100	133.33-200	100	100-100	100-116.67	75.19-100

combination of the following characters, only two black bands: one descending to the middle of the pectoral fin and the other across that portion of the anterior caudal peduncle which is above the anal fin; caudal fin and the flank of lateral side distinctly red. Dorsal fin with two to three black bands. Dorsal spine serrated posteriorly. 8 prepelvic and 12 preanal scales are present. Lateral line incomplete with 6 pores.

Descriptions: Branchiostegal rays 4, D. 2/8, P. 1/15, V. 1/7, A. 2/5, C. 18, L.l. 21-23, L.tr. 5½/3½. Dorsal and ventral profiles arched equally. Head short conical. Mouth terminal. Barbel absent. Dorsal fin slightly nearer to the base of caudal fin. Last unbranched dorsal ray less than length of head and depth of body. Width of mouth more or less equal to internasal distance. Length of dorsal fin base greater than height of caudal peduncle. 8 predorsal scales.

Proportional measurements of holotype and paratypes (in parentheses): Depth of body 27.32 (25.64-26.66), length of head at end of lateral operculum 22.72 (20.00-23.09) and length of head at occiput 13.64 (13.79-15.38) in total length. Length of caudal fin 29.41 (28.57-30.03), length of head at occiput 17.66 (17.73-20.00), width of body at dorsal fin origin 14.70 (16.66-17.15), width of body at anal fin origin 11.75 (11.42-13.33) length up to preanal opening 70.92 (68.96-75.18), preanal length 73.52 (71.42-78.74), prepelvic length 44.24 (45.87-53.47), predorsal length 47.16 (51.54-53.47), length of head at the end of lateral operculum 29.41 (25.77-30.03) and depth of body 35.33 (33.33-34.36) in standard length.

Interorbital distance 40.00 (33.33-44.44), length of head at occiput 68.24 (66.66-68.96), diameter of eye 25.00 (22.22-27.77), length of pectoral fin 88.42 (87.29-89.29), depth of head at occiput 60.24 (78.12-78.12), length of snout 25.00 (22.22-27.77), internasal distance 20.00 (22.22 - 22.22), length of caudal peduncle 60.24 (66.66-78.12), height of caudal peduncle 50.00 (44.44-55.55) and length of dorsal fin base 60.24 (57.80-72.46) in head length at the end of lateral operculum.

Colour: Dorsal side of body greenish to blackish. Dorsal fin with 2 to 3 (mainly 2) black bands. Pectoral fin blackish. Ventral and anal fin blackish-red to red. Tip of snout black with minute black dots. Caudal peduncle spot present on the 16th to 18th scales along the lateral line. 3rd and 4th lateral line scales bear the first black blotch.

Etymology: From the Manipuri word 'Meingangbi' meaning red coloured tail; allusion to the ground colour of body, treated as an adjective in apposition.

Discussion: *Puntius meingangbii* is widely distributed in Manipur State. It is easily distinguished from *P. phutunio* by the distinct red coloration of flank and caudal fin, with two black bands on the lateral sides of body. In *P. phutunio*, four black bands are present on the lateral sides of body instead of two black bands. The dorsal fin base of *P. meingangbii* is greater than the height of caudal peduncle but it is less in *P. phutunio*. The meristic characters are also different from *P. phutunio*, namely branched ventral rays (7 vs. 8), unbranched anal rays (2 vs. 3), total caudal rays (18 vs. 19) and lateral line scale to origin of dorsal fin scales (5½ vs. 3½) and prepelvic scales (8 to 7 vs. 5 to 6) (Table 1). The morphometric characters are also different from *P. phutunio*, namely height of head at occiput (66.66 to 68.96 vs. 84.61 to 100), length of snout (22.22 to 27.77 vs. 28.57 to 33.33) in length of head, and diameter of eye (62.5 to 75.18 vs. 75.00 to 133) in interorbital distance (Table 2).

P. meingangbii also differs from *P. gelius* in the following distinctive characters: last unbranched dorsal ray less than length of head and depth of body, branched ventral rays (7 vs. 8), unbranched anal rays (2 vs. 3), total caudal rays (18 vs. 19). Preanal scales (12 vs. 13), prepelvic scales (8 vs. 6), depth of body (33.33 to 35.33 vs. 23.81 to 30.77) in standard length.

Height of head at occiput (66.66 to 68.96 vs. 66.67 to 100), length of snout (22.22 to 27.77 vs. 33.33 to 40.00), diameter of eye (22.22 to 27.77 vs. 33.33 to 50.00) in percentage of length of head, (100.00 vs. 79.19 to 100) in percentage of snout, (62.5 to 75.18 vs. 75.19 to 100) in percentage of interorbital distance (Table 2).

Materials Compared: *Puntius gelius* ZSI, F. 13073/1, 1 ex., 20.00 mm SL, Dhamtari Bazar, Mahanandi. *Puntius phutunio* ZSI, F.2120/2, 3 ex., 21.00-22.00 mm SL, Darrang, Assam. ZSI, F.2518/2, 2 ex., 38.00-38.5 mm SL, Medha, Satara district; collected by S.P. Agharkar.

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DESCRIPTION OF A NEW IDIOCERINE GENUS *PERIACERUS*, HEMIPTERA: CICADELLIDAE, AND TWO NEW SPECIES FROM INDIA AND SRI LANKA[1]

(*With twenty-nine text-figures*)

C.A. Viraktamath[2] and C. Parvathi[2, 3]

Key words: *Periacerus* gen. nov., *Periacerus bidentatus* sp. nov., *Periacerus lankensis* sp. nov., India, Sri Lanka

Periacerus gen. nov. (type species: *Idioscopus lalithae* Viraktamath) is described. The new genus and the Afrotropical genus *Pandacerus* Webb share similar structure of second pair of gonapophyses including the apical hyaline region and male style. Basally constricted clypellus, longer laterofrontal sutures above antennal pit, distinct basal lobe of subgenital plate, dorso-lateral fracture of the male pygophore, in addition to closed inner and median anteapical cells of fore wing and the transversely striated upper part of face distinguish *Periacerus* from *Pandacerus*. Two new species, *Periacerus bidentatus* sp. nov. (from India: Coimbatore, Mudigere) and *Periacerus lankensis* (from Sri Lanka: Hakgala) are described and illustrated. A key to species is also provided.

Introduction

During the study of the Idiocerinae of the Indian subcontinent with a view to evaluate the taxonomic value of female characters, it became apparent that *Idioscopus lalithae* Viraktamath is misplaced in the genus *Idioscopus* Baker. Viraktamath (1979) mentioned that the species deserves the "erection of a new genus as it forms an atypical member of *Idioscopus*". Recently, a collection of leafhoppers from the Natural History Museum, London (BMNH) became available for the study. These collections included two more species closely related to *I. lalithae*, strengthening the ground for the erection of a new idiocerine genus for their reception.

Periacerus gen. nov.

Type species: *Idioscopus lalithae* Viraktamath.

Ochraceous with a dark brown to black band on posterior margin of pronotum. Vertex without black spots. Face with or without black spots adjacent to ocelli.

Head broader than pronotum. Face including eyes wider than long. Length of inner margin of eye 0.8-0.86 perpendicular length of face below eye. Lateral frontal sutures extending beyond antennal pits to half distance between ocellus and antennal pit. Male antenna with a subapical disc. Transclypeal sulcus absent. Lateral areas of clypellus in basal 0.66 strongly depressed beyond which clypellus is widened. The ratio of maximum width of clypellus to minimum width is more than 1.5. Lora raised, their upper extremity reaching half-length of frontoclypeus. Gena below antennal pit obliquely rugose. Ratio of interocular to ocellocular is 1:2. Area of head above ocellus transversely striate. Scutellum longer than pronotum. Fore wing with four apical and three anteapical cells, the latter closed behind; outer anteapical cell 0.33-0.25 as long as median, appendix large, wider than width of any anteapical cells. Hind femoral spinulation 2+1. Hind tibial spinulation R, 20 ±3, R2 8 ±1, R3 9 ±1. Hind basitarsus with three platellae on transverse row with one seta on either side.

Male eighth sternum well sclerotized with anterior pair of prominent apodemes. Ninth tergum with well-developed pair of dorsal apodemes. Anal

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Mudigere 577 132, Karnataka, India.

collar well developed, caudally produced into a bilobed process. Tenth segment well sclerotized. Pygophore with dorsolateral fracture, 0.2 as high as long, without processes. Subgenital plate well sclerotized held vertically, broader than height of pygophore, with long hair-like marginal setae, basal segment prominent. Style elongate, preapical lobe lateral, prominent with 2-3 long setae, apophysis with expanded apical process laterally. Connective T-shaped, with well-developed dorsal keel. Aedeagus U-shaped, compressed, dorsal apodeme well developed, shaft elongate, with or without a pair of short processes, gonopore subapical on caudal margin.

Ovipositor extending well beyond pygophore. Gonocoxae I with an angular projection on ventral margin; gonapophysis I with rounded posterior basal shoulder and anterior outer shoulder; striations extending to 0.75 of length. Gonapophysis II broadest in proximal 0.33 with denticulate area saw-like, occupying 0.75 of total length; denticles prominent with an apical hyaline region.

Remarks: *Periacerus* looks similar to the Afrotropical genus *Pandacerus* Webb (1983) as both the genera share similar structure of second pair of gonapophyses including the apical hyaline region. However, basally constricted clypellus, longer latero-frontal sutures above antennal pit, distinct basal lobe of subgenital plate, dorso-lateral fracture of the male pygophore, in addition to closed inner and median anteapical cells of fore wing and the transversely striated upper part of face distinguish *Periacerus* from *Pandacerus*.

Etymology: *Periacerus* alludes to the place of collection of the type species namely Periyar Wildlife Sanctuary, "cerus" is commonly used in the generic ending of the subfamily Idiocerinae.

KEY TO SPECIES OF *PERIACERUS*

1. Face with median black stripe extending from frontoclypeus to basal half of clypellus (Fig. 9); rounded lobe of anal collar process crenulate (Fig. 13) (Sri Lanka: Hakgala) ...... *lankensis* sp. nov.
— Face without such a stripe (Figs 1, 22), or if present, light brown extending the entire length of frontoclypeus and clypellus with a chocolate brown spot; round lobe of anal collar process entire (India) 2
2. Aedeagal shaft with a pair of short processes (Figs 27, 28) (India: Coonoor; Mudigere) .... *bidentatus* sp. nov.
— Aedeagal shaft without processes (India: Thekkadi) .... *lalithae* Viraktamath

Periacerus lalithae (Viraktamath) comb. nov.

Figs 1-7

Idioscopus lalithae Viraktamath, 1979: 177-179, Figs 22-32. Holotype ♂, India [UAS, examined]

Viraktamath (1979) has adequately described the species. The following are the additional characters.

Female genitalia: Hind margin of seventh sternum caudally produced with a median notch. Gonocoxae and gonapophysis as in Figs 3-7.

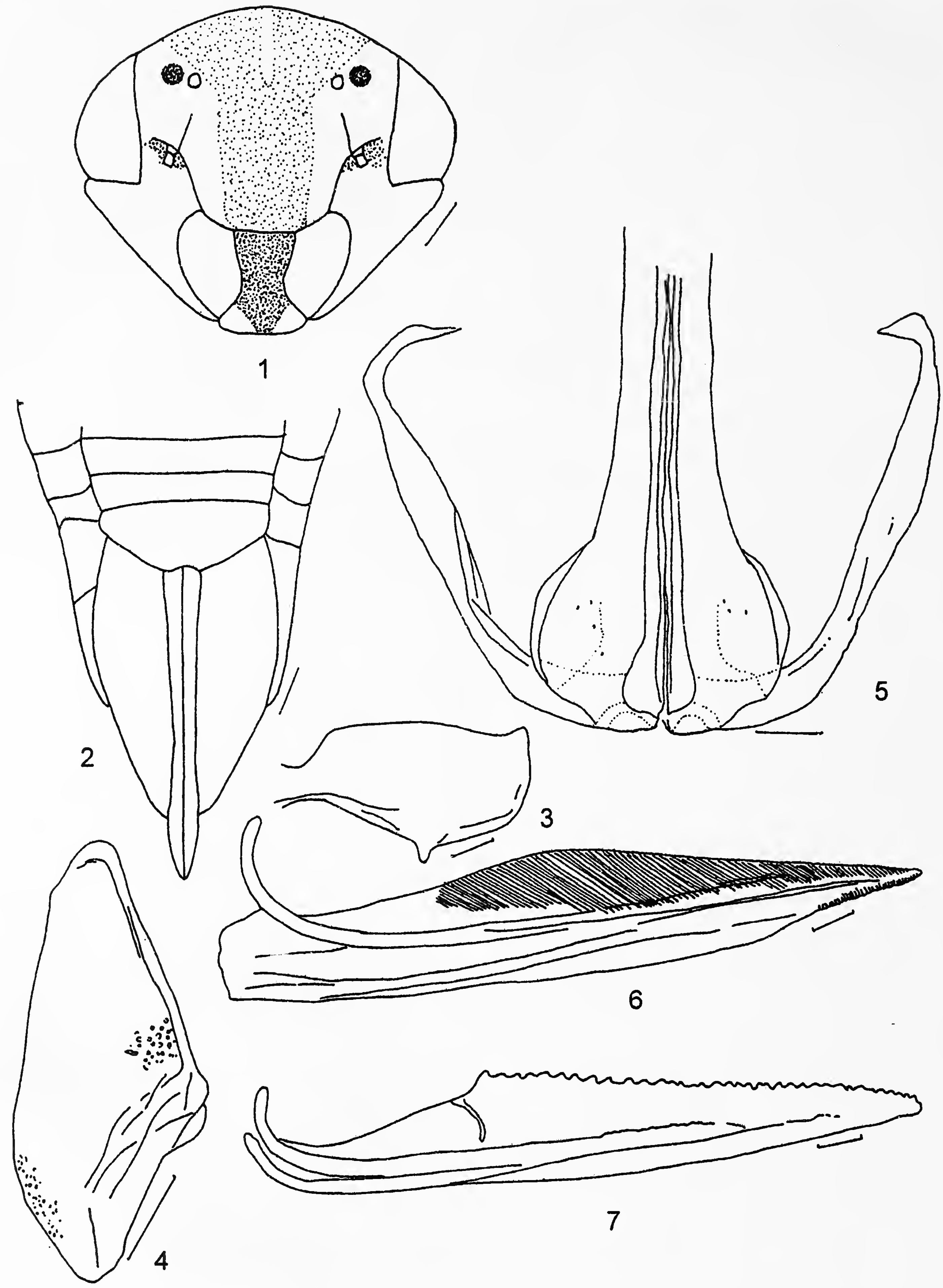
Material examined: Holotype ♂, INDIA: Kerala: Thekkadi [Periyar Wildlife Sanctuary], 26.iii.1977, C.A. Viraktamath Coll. (UAS). Paratypes 3 ♀, data as for holotype but 1 ♀ collected on 26.iii.1977 by B. Mallik, 1 ♀, collected on 27.iii.1977 by S. Viraktamath (UAS).

Remarks: It is closely related to *P. lankensis* but can be readily distinguished by the strongly apically hooked aedeagal shaft, more prominent expansion on the apophysis of style. Pronotal coloration is very variable. In darker specimens, the pronotal band is darker than in *lankensis* and in darker females the facial stripe is brownish with part of clypeus chocolate brown to black.

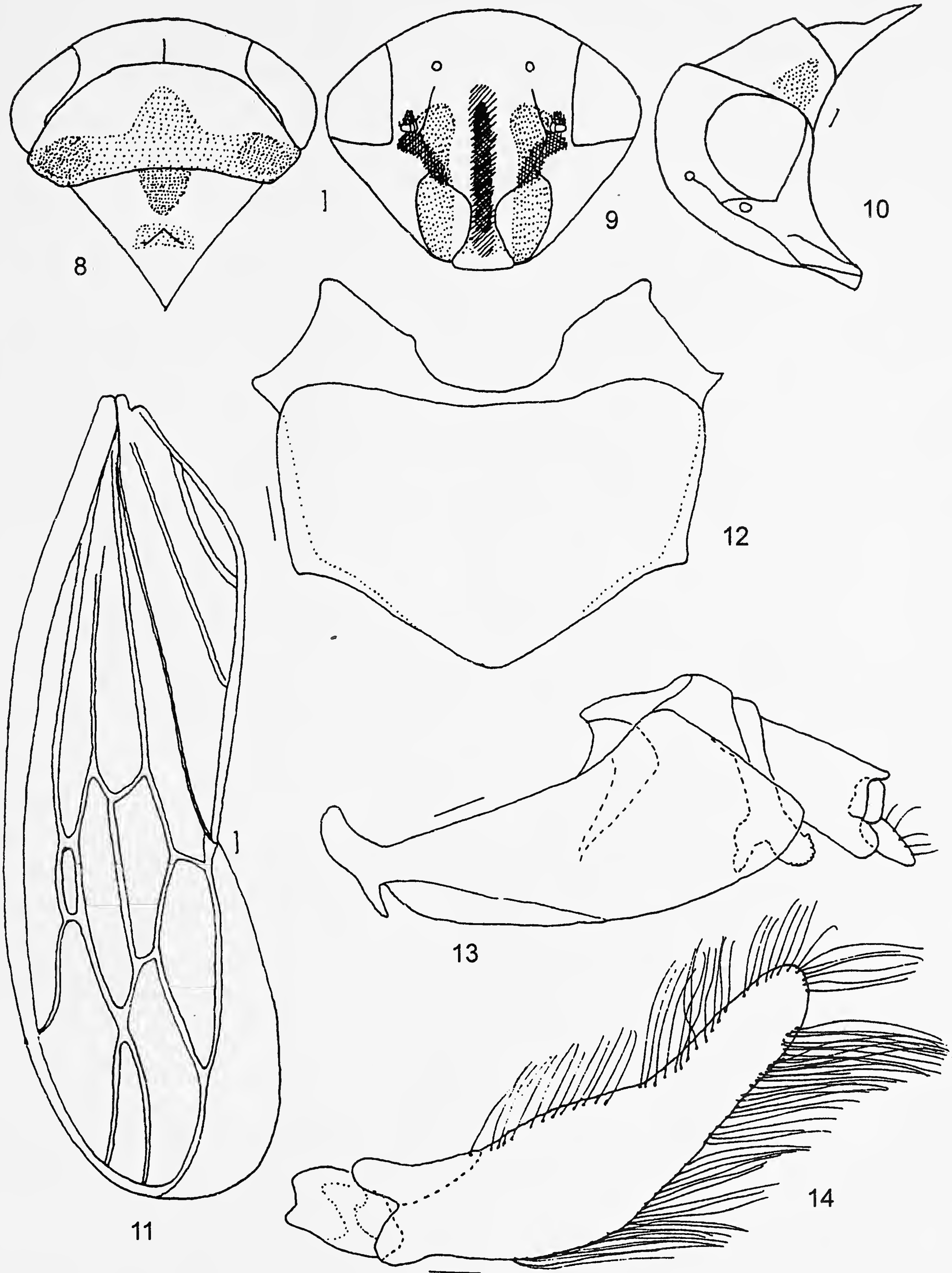
Periacerus lankensis sp. nov.

Figs 8-20

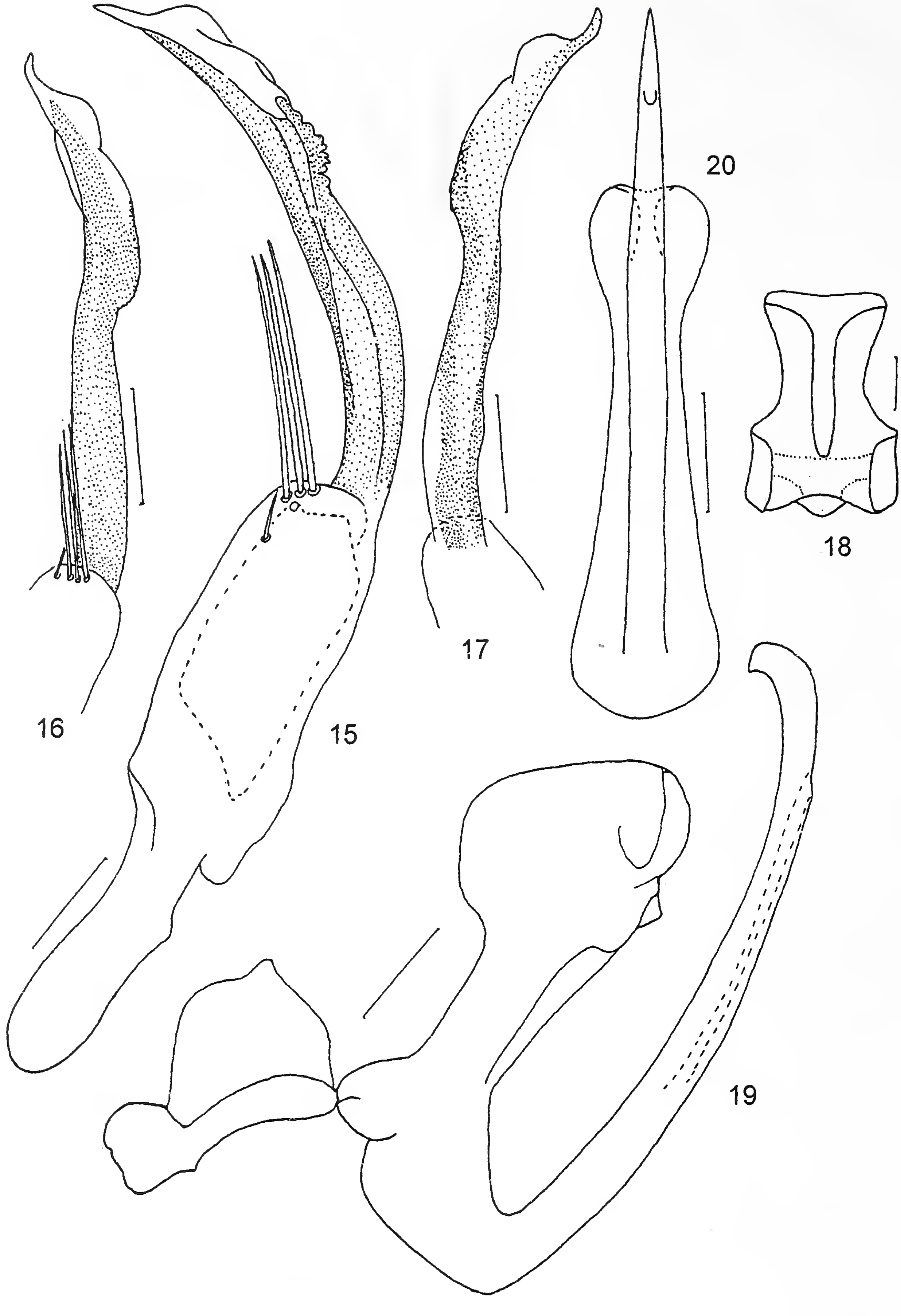
Ochraceous. A median stripe on lower half of frontoclypeus running entire length of clypellus, a lateral stripe on either side of this running on lateral margin of lower half of



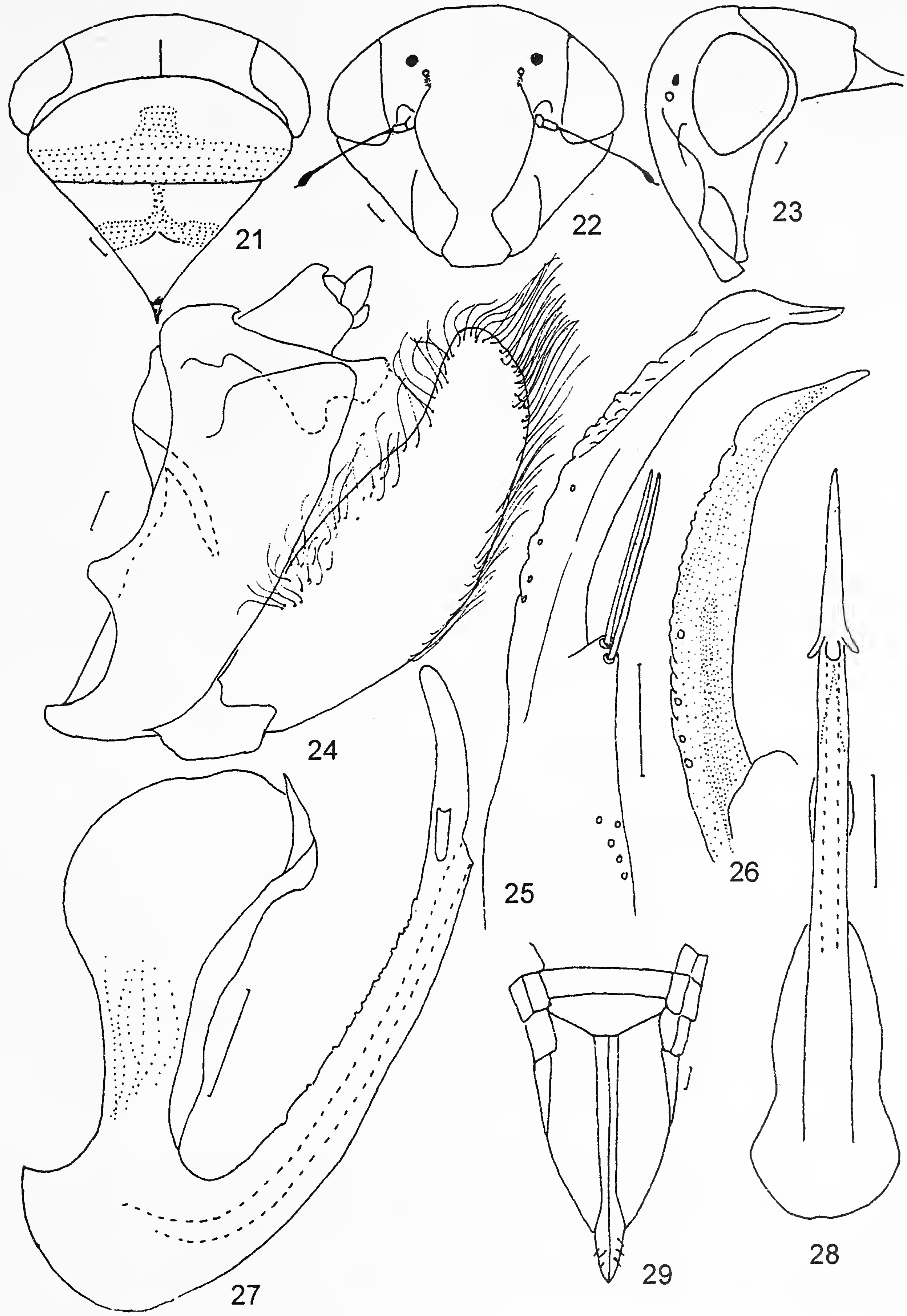
Figs 1-7: *Periacerus lalithae* (Viraktamath), 1. Face, 2. Female ovipositor, 3. Gonocoxa I, 4. Gonocoxa II, 5. Base of gonapophysis I and gonocoxae, 6. Gonapophysis I, 7. Gonapophysis II
(Scale line indicates 0.1 mm)



Figs 8-14: *Periacerus lankensis* sp. nov., 8. Head and thorax, 9. Face, 10. Head and thorax, profile, 11. Fore wing, 12. Male eighth sternum, 13. Male genital capsule, 14. Subgenital plate (Scale line indicates 0.1 mm)



Figs 15-20: *Periacerus lankensis* sp. nov., 15. Style, 16, 17. Different aspects of apophysis of style, 18. Connective, 19. Connective and aedeagus, lateral view, 20. Aedeagus, ventral view
(Scale line indicates 0. 1 mm)



Figs 21-29: *Periacerus bidentatus* sp. nov., 21. Head and thorax, 22. Face, 23. Head and thorax, profile, 24. Male genital capsule, 25. Apical half of left style, 26. Same right style, 27. Aedeagus, lateral view, 28. Same, ventral view, 29. Female genitalia (Scale line indicates 0.1 mm)

frontoclypeus, extending on to lorum dark brown. Transverse band on posterior margin of pronotum brownish, lateral areas of band darker. A central large spot on anterior half of scutellum brownish. Fore wing with apical half of clavus mesad of outer claval suture greenish-yellow; venation dark brown. Fore and mid tarsi, apical 0.33 of fore and mid tibiae dark brown to piceous.

Male genitalia: Pygophore gradually increasing in depth caudally, with strong apodemes on anterior margin both dorsally and ventrally. Anal collar process bifid caudally. Style as in Fig. 14. Connective broad basally, 1.5 times as long as wide at base. Aedeagal shaft slender, compressed, apex slightly hooked.

Female: Unknown.

Measurements: Male 4.90-5.50 mm long and 1.60-1.70 mm wide across eyes.

Material examined: SRI LANKA: Holotype ♂, "Hakgala, Ceylon, v.1911" (BMNH).

Paratypes: 2♂, data as for holotype (BMNH).

Remarks: See under *P. lalithae.*

Periacerus bidentatus **sp. nov.**

Figs 21-29

Ochraceous. A broad area on vertex, continued on face to ocelli, posterior marginal band to pronotum with a median anterior projection, two spots on scutellum and wings brownish. A latero-dorsal spot and a ventral spot to each ocellus in female and antennal disc in male piceous. Ocelli vitreous or pink. Costal margin yellowish; veins brown.

Male genitalia: Pygophore increasing in depth caudally, with anterior dorsal and ventral apodemes. Anal collar process caudally bifid, dorsal fork broader with truncate apex compared to ventral fork. Subgenital plate broadest at basal half. Style as in Fig. 22. Aedeagal shaft not hooked apically, anterior margin serrated, with a pair of short ventrally directed lateral processes near gonopore.

Female genitalia: Hind margin of seventh sternum slightly medially produced without a median notch. Gonapophysis I and II as in *P. lalithae.*

Measurements: Male 5.80-6.00 mm long and 1.75-1.76 mm wide across eyes. Female 6.40 mm long and 1.95 mm wide across eyes.

Material examined: INDIA: Holotype ♂, "Muthikolam, 3000" [910 m], Coimbatore Dt., S. India, 23-26.ix.[19]38" and on reverse of the label "B.M.-C.M. Expdn to S. India, Sept.-Oct. 1938" (BMNH).

Paratypes: 1♂, data as holotype [stylopised], 1♀, "Coonoor, 6,000 ft [1,820 m], S. India, 22-23. iv.[19]37" and on reverse of the label "B.M.-C.M. Expdn to S. India, April-May 1937" (BMNH). 1♂, INDIA: Karnataka: 19 km W of Mudigere, 6.vi.1980, C.A. Viraktamath Coll. No. 227 (UAS).

Remarks: Externally this species resembles *P. lalithae.* The type series are teneral except for a male from Mudigere and hence the coloration of pronotum is not very well developed. The black spots on the face are also variable in male and female. The species can readily be recognised by the short processes on the aedeagal shaft in addition to facial coloration.

ACKNOWLEDGEMENT

We are grateful to Dr. M.D. Webb (BMNH) for allowing us to borrow leafhopper material used in this study and also for his comments on the relationships of the genus *Periacerus* with *Pandacerus.*

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MELICERTUS SIMILIS, A NEW SPECIES OF PRAWN, DECAPODA: PENAEIDAE, FROM INDIA[1]

(*With six text-figures*)

ANGSUMAN CHANDA AND TANMAY BHATTACHARYA[2]

Key words: *Melicertus similis* sp. nov., Penaeidae, prawn, shrimp

A new species of penaeid prawn *Melicertus similis* from Andaman Sea at Port Blair in India is described. This new species is similar to *Melicertus canaliculatus* (Olivier 1811) but can be distinguished from it by the presence of a short ischial spine on the first pereiopod, absence of disto-median projection on petasma, a chisel-shaped anterior plate on the thelycum and a wide gap between lateral plates.

INTRODUCTION

The genus *Penaeus* was subdivided into six subgenera (Holthuis 1980). Recently, these subgenera were raised to generic rank by Perez-Farfante and Kensley (1997). The genus *Melicertus* is represented by two species in the Indian sub-region namely, *M. canaliculatus* (Olivier 1811) and *M. latisulcatus* (Krishinouye 1896). The material on which the present paper is based was collected by Dr. H.C. Roy of the Zoological Survey of India (ZSI) in 1952 and is preserved in the ZSI collection. The species status of this collection had remained undetermined since then. The specimens are apparently similar to *M. canaliculatus* (Olivier 1811). Close examination, however, revealed it to be a species hitherto undescribed and new to science. A detailed description is given below.

Much of the terminology used in the description is after Perez-Farfante (1976). Carapace length is the distance between the orbital margin and the mid-posterior margin of the carapace, and total length is the distance from the apex of the rostrum to the telson.

Melicertus similis sp. nov.
(Figs 1-6)

Material examined: Port Blair, Andaman Is., Bay of Bengal, 24.iii.1952; holotype: 1 female, 75 mm; allotype 1 male, 59 mm, paratypes: 3 females, 75-80 mm & 3 males, 59-60 mm; all from the same locality.

The types are deposited in the reference collection of the Zoological Survey of India Regn. No. C4622/2 (holotype), C4624/2 (allotype) and C4623/2 (paratypes).

DESCRIPTION

Rostral tooth 10-11/ 1 (10 in male; 11 in female), ventral tooth placed beyond the frontal dorsal teeth. Rostrum reaching almost to tip of antennular peduncle, curving downward up to ventral tooth, reaching its greatest height at fifth tooth, distal non-toothed portion slightly upcurved. Post-rostral carina feebly sulcate, post-rostral sulcus nearly half of carapace length. Dorsal carina extending up to 0.95 of length of carapace from anterior margin.

Gastro-frontal sulcus deep, bifurcated posteriorly, small carina causing this bifurcation reaching nearly one-third length of sulcus; gastro-frontal carina prominent and extending to orbital angle, forming blunt supraorbital spine. Antennal spine long. Gastro-orbital carina pronounced, ending near the orbital angle. Hepatic spine prominent and short orbito-frontal sulcus narrowing posteriorly and reaching hepatic sulcus, cervical sulcus reaching orbito-antennal sulcus from upper side of hepatic spine, branchiocardiac carina very thin.

Antennular flagella very small and

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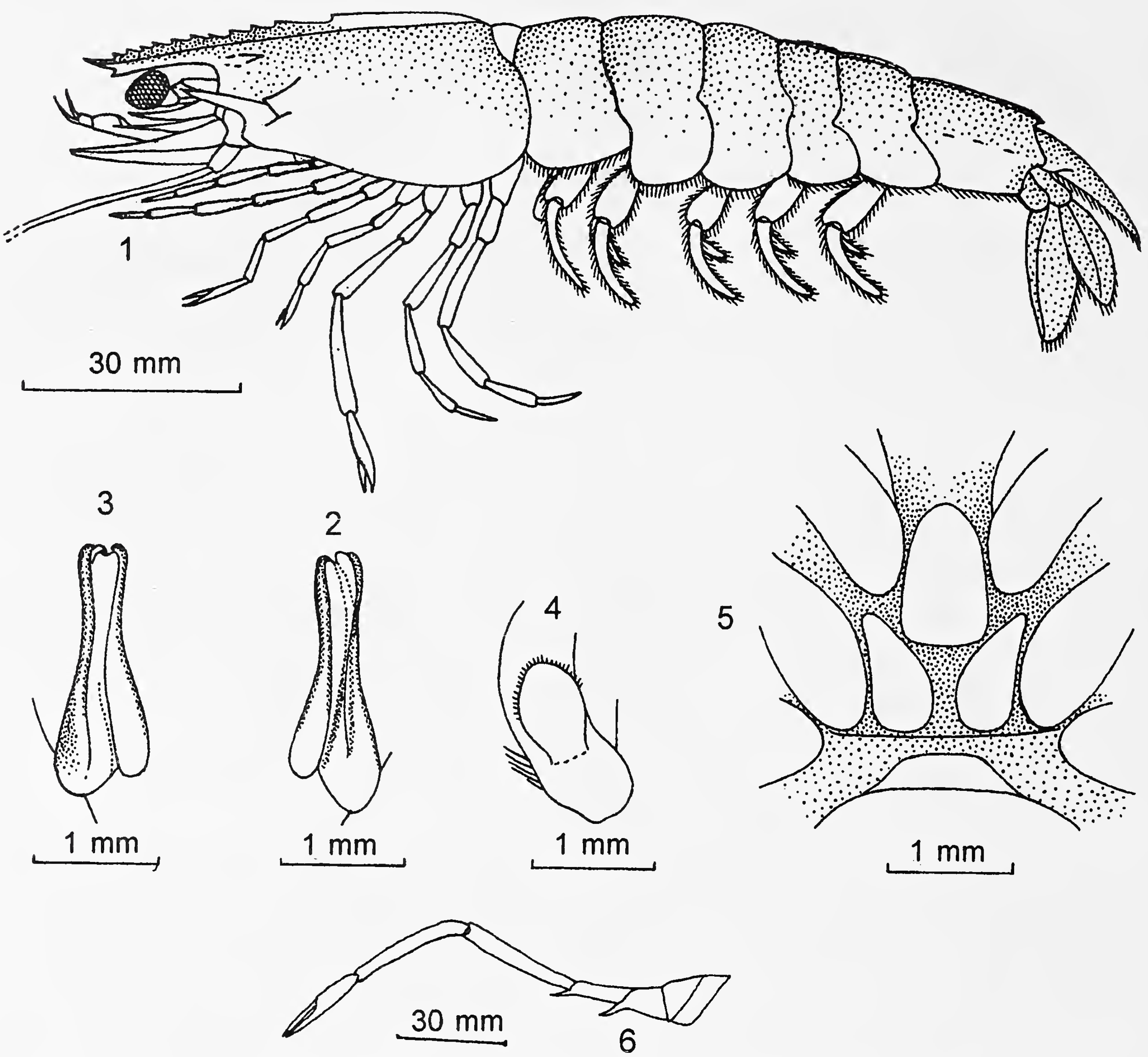

Figs 1-6: *Melicertus similis* sp. nov., 1. Lateral view, 2. Dorsal view of Petasma, 3. Ventral view of Petasma, 4. Appendix masculina, 5. Thelycum, 6. First pereiopod

subequal, one-fourth length of peduncle. Prosartema not exceeding the basal segments stylocerite attaining mid-length of basal segment.

Third maxilliped extending up to second antennular segment. First pereiopod extending up to the base of first segment of antennular peduncle, second extending beyond half of the first antennular segment, third extending up to third antennular segment. Fourth extending up to tips of stylocerite and fifth up to the mid-length of first segment of antennular peduncle.

Dorsal carination extending from middle of fourth abdominal somite up to end of sixth somite with a downward curved tooth. Telson without spine, sixth somite with 3 lateral cicatrices.

Petasma reaching the level of coxa of fifth pereiopods. Median lobe separated from lateral lobe by a shallow smooth depression, lateral lobe slightly curved ventrally.

Distal piece of *appendix masculina* is slightly longer than its width, symmetrical and oval, the distal half of anterior surface covered with small setae. Basal piece twice the length of distal piece.

Anterior plate of thelycum chisel-shaped, anterior portion slightly ridged, postero-ventral surface concave, posterior part wide and leaves a considerable gap to the seminal receptacle. A

Table 1: Distinctive characters of three related species of *Melicertus*

Features	*M. similis* sp. nov.	*M. canaliculatus*	*M. longistylus*
Carapace	Cervical sulcus reaching orbito-antennal sulcus from upper side of hepatic spine	Cervical sulcus not reaching orbito-antennal sulcus	Cervical sulcus not reaching orbito-antennal sulcus
First Pereiopod	Bears a short ischial spine	Ischial spine absent	Bears a short ischial spine
Telson	Without spine	Without spine	With 3 movable spines
Petasma	There is no disto-median projection	A short disto-median projection present	A prominent disto-median lobe present
Thelycum	Presence of a chisel-shaped anterior plate; a wide gap between lateral plates	Anterior plate absent, lateral plates placed close to each other with no space between the median margins	Anterior plate pentagonal, lateral plates placed close to eachother with no space between the median margins

wide gap between two lateral plates; dorsally these are concave; anteriorly they are narrow and curved on the outside.

Body colour: Body uniformly creamy white in preserved specimens.

Distribution: Known only from the type locality.

Etymology: The specific name '*similis*' relates to the similarity between the new species and *M. canaliculatus* in appearance.

Discussion: The new species is similar to *Melicertus canaliculatus* (Olivier 1811). A close examination also shows some similarities with *M. longistylus* (Kubo 1943). The structures of the petasma and the thelycum justify a distinct species status. The shape and size of the anterior thelycal plate is quite different. It is completely chisel-shaped in *M. similis*, nearly pentagonal in *M. longistylus* but absent in *M. canaliculatus*. Lateral plates are quite close in both *M. longistylus* and *M. canaliculatus* as compared to those in *M. similis*. Telson of *M. longistylus* has three pairs of lateral movable spines, but in *M. similis* there is no lateral spine. This character relates the new species to *M. canaliculatus* (Olivier 1811). These three species may be distinguished by the features listed in Table 1 and a diagnostic key for all the Indo-Pacific species of *Melicertus* which is given below.

Key to species of *Melicertus*

1. Telson with movable spine 2
— Telson without movable spine 5
2. Presence of sulcus on post-rostral carina, one ventro-rostral tooth 3
— Absence of sulcus on post-rostral carina, one ventro-rostral tooth .... *M. marginatus* (Randall 1840)
3. Gastro-frontal sulcus bifurcate 4
— Gastro-frontal sulcus trifurcate .... *M. plebejus* (Hess 1856)
4. One ischial spine present on first pereiopod .... *M. longistylus* (Kubo 1943)
— Ischial spine on first pereiopod absent .... *M. latisulcatus* (Krishinouye 1896)
5. Anterior thelycal plate absent .... *M. canaliculatus* (Olivier 1811)
— Anterior thelycal plate chisel-shaped .... *M. similis* sp. nov.

Acknowledgements

We thank Dr. J.R.B. Alfred, Director, Zoological Survey of India, Kolkata for facilities. One of the authors (AC) is grateful to Zoological Survey of India. Ministry of Environment and Forests, Government of India for grant of a research fellowship and to Dr. Tusarendu Roy, Officer-in-Charge, Crustacean Section, Zoological Survey of India for making the collection available for study and for guidance. The authors are also grateful to Dr. L.B. Holthuis for his critical comments.

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REVIEWS

1. MEDICINAL PLANTS by S.G. Joshi. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. Pp. 491 (24 x 18 cm). Price Rs. 495/-.

With increasing interest Ayurveda, the ancient Indian system of medicine, has become popular in the western world, and many books on medicinal plants are available in the market. This book provides information on medicinal plants belonging to 106 families, arranged in alphabetical order, starting with Acanthaceae and ending with Zygophyllaceae, thereby making it easy to refer.

Besides the botanical name of each plant, it also has synonyms of the plant along with English and vernacular names wherever available. The names in Sanskrit, which are often used in Ayurvedic books, are also given under each species. There are separate indices for Botanical names, and names in English, Sanskrit and other Indian languages.

The author has also given the habit and habitat of each species, the chemical composition of the plant and parts used in Ayurvedic medicines, followed by Therapeutics. The 'shlokas' in Sanskrit describing the properties of the plant are given in Devnagari as well as Roman script, along with properties like Rasa, Guna, Virya, Vipak among others, making it useful for the students of Ayurveda. In the foreword, Vaidya M.G. Wadalkar of Tilak College of Ayurveda, Pune has explained the Ayurvedic terms used in the book for different properties of the plant. In the preface, the Late Dr. V.D. Vartak, ex Director, Maharashtra Association for the Cultivation of Science, has mentioned the history of Ayurveda and herbal medicines.

There is an error in numbering the families: Family Iridaceae and Juglandaceae have been numbered as XLVIII and Family Lamiaceae as XLIX in the text and contents page, instead of XLVIII, XLIX and L respectively; this should be corrected in the next edition.

The black and white illustration of each species along with the text adds value to the book, which is an excellent reference not only for students and practitioners of Ayurveda, but also for students of botany and others interested in herbal medicine.

■ NARESH CHATURVEDI

2. MONITORING TIGERS AND THEIR PREY: A MANUAL FOR RESEARCHERS, MANAGERS AND CONSERVATIONISTS IN TROPICAL ASIA, Edited by K. Ullas Karanth & James D. Nichols. Published by Centre for Wildlife Studies, Bangalore. Pp. 193 (25.5 x 20 cm). Price Rs. 395/-.

In India, long term and short term monitoring of wildlife populations is either non-existent or of a dubious nature. Despite the noise made during meetings, that census and monitoring of wildlife should be done annually, especially in major protected areas, we still do not have a good monitoring system that can withstand the scrutiny of science. Our wildlife census varies from the farcical (giving the exact number of rats, pythons, mongoose in a large tiger reserve!) to fairly accurate (lions in and around Gir). Even with good field experience, counting animals accurately is a difficult job, with chances of an error at every stage. If inexperienced and/or uninterested persons, with little or no knowledge of techniques, conduct census then inaccurate figures are inevitable. That is why either the population estimates are low or very high (generally the latter in the case of the glamorous species such as tigers, leopards, rhino).

This book will help us learn proper census and monitoring techniques of wild animals. Both

Dr. Ullas Karanth and Dr. James Nichols are well-known field biologists, each with more than 20 years of experience. Ullas has done pioneering studies on the ecology of the tiger, mainly in Nagarhole and Bandipur, while James is known for his work on animal population dynamics and wildlife management, with a special focus on estimation of demographic parameters.

MONITORING TIGERS AND THEIR PREY consists of 13 chapters, each complete in its own, including references. Ullas is the co-author of 12 out of the 13 chapters, so basically it is his book. Wherever necessary, good line diagrams, maps and graphs are given which makes explanation easy. Knowledge of basic statistics is required to fully understand the various methods of density estimation. If a person does not have basic knowledge, he/she should not undertake a census or monitoring exercise in the first place.

The editing is not up to the mark. Perhaps, in the second edition, the authors should take the help of a professional editor. The size of the book makes it difficult to carry in the field. These are minor drawbacks and should not prevent its wide use in India and other countries. Now managers should not be able to say that a good, easy to understand and inexpensive manual on monitoring is not available. Instead of building another hideous watchtower or a waterhole to spend unutilized funds before the end of the financial year, I request forest officials to purchase copies of this valuable book. It should be present in each protected area and in each range office. Once it is widely used, I hope we will not hear Ullas's lament "Lack of resources or training should not be used as an excuse to practise substandard science."

■ ASAD R. RAHMANI

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MISCELLANEOUS NOTES

1. PALE HEDGEHOG *PARAECHINUS MICROPUS* IN SOUTHEAST RAJASTHAN

The pale hedgehog *Paraechinus micropus* has long been considered a species inhabiting deserts and arid plains of India. According to Prater (1988), the hedgehog is confined to the dry desert zone of Kutch, Sindh, Punjab and the former NWFP and the neighbouring tracts. Its presence in the wetter, greener parts of southeast Rajasthan was established when some villagers of Thegda village accidentally caught a specimen 5 km from Kota city (25° 10' N, 75° 52' E) on February 14, 2000. The animal was brought to me, photographed, kept to recuperate for two days and later released in the habitat where it was caught. Kota receives more than 60 cm rainfall per annum. Thegda village is situated on the banks of Right Main Canal and is famous for guava (*Psidium guajava*), orchards and vegetable fields. Later, Dr. Himmat Singh and I searched for possible hideouts of hedgehogs and found pale hedgehog holes under jujuba bushes *Zizyphus jujuba*, which were used as diurnal hideouts by the animal. The long-eared *Hemiechinus auritus* (Kuowa) as well as pale hedgehogs were seen only west of the Aravalli range by Dr. Himmat Singh (2000).

My enquiries revealed that a pale hedgehog was caught in a factory, not very far from Thegda village in 1996. Again in December 2000, some tribals were found selling four pale hedgehogs as pets at Raipura village, about 8 km from Kota city. All these animals were released in the wild. On further investigation during field trips, I was told that this species is found east of Deoli which is 95 km west of Kota and receives an average rainfall of about 40-50 cms. It is now well established that the pale hedgehog has adapted itself to wetter habitats and is found further east than was earlier presumed.

October 8, 2001

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2. SIGHTING OF THE SMOOTH OTTER (*LUTRA PERSPICILLATA*) IN NAGAI DISTRICT ALONG THE BAY OF BENGAL COAST, TAMIL NADU STATE

During a survey of migratory birds along the River Uppaner in Sirkali Taluk, Nagai District of Tamil Nadu State, we came across an otter on February 9, 2000 at 1630 hrs. We set out on a boat from Soorakkadu village, near the town of Sirkali and moved downward towards the ocean, near the village of Thirumulaivasal. About 1,200 m from the sea, we saw an otter coming out of the water. We stopped the boat and observed the otter for about three minutes. After seeing us, the otter turned around and moved on to the nearby *Prosopis juliflora* vegetation. We walked along the river and saw several footprints and remains of the otter's fish food. The habitat has a coconut farm and an abandoned shrimp farm. Interview with locals indicated a small otter population inhabiting the area with no apparent sign of hunting pressure. This is the first recorded

case on the occurrence of this species from this area (Nagai district). Three species of otters namely the Asian small-clawed otter *(Aonyx cinerea)*, smooth otter *(Lutra perspicillata)* and Eurasian otter *(Lutra lutra)* occur in India. Although the smooth otter is found throughout India, little is known about its population status and distribution in Tamil Nadu. Otters in general are becoming increasingly rare outside of national parks and wildlife sanctuaries, and are threatened in many areas due to poaching, habitat destruction and reduction in prey biomass (Foster-Turley *et al.* 1990). Otters are at the top of the food chain and they are indicators of habitat quality. When pollutants such as heavy metals and organochlorines like PCBs contaminate the environment, otters are among the first species to disappear (Mason and MacDonald 1986). The sighting of an otter along the coastal area in Nagai district indicates that this species can survive in an unprotected area if the environment is healthy and if locals do not harm them. Further surveys are vital to estimate the population status of otters outside protected areas in Tamil Nadu State.

We thank Mr. Poo Munian for arranging a boat for the survey, and Mr. G. Natarajan for accompanying us in the field. We also thank their families for hospitality.

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3. IDENTIFICATION OF DORSAL GUARD HAIRS OF STRIPED HYENA *HYAENA HYAENA* (LINNAEUS, 1758) HYAENIDAE: CARNIVORA: MAMMALIA

(*With one plate*)

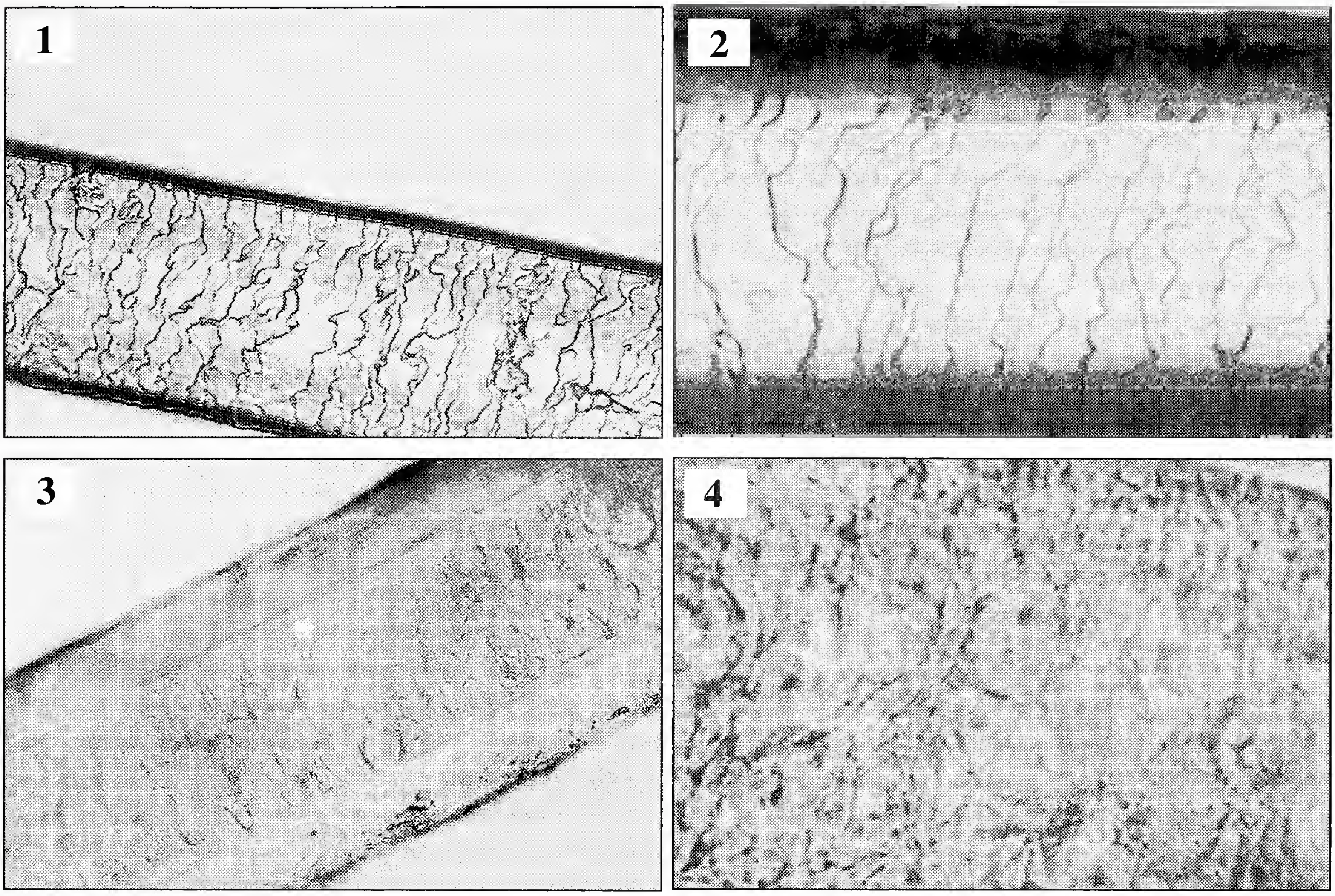
Hyaena hyaena, an efficient nocturnal forest scavenger, is distributed in northern and eastern Africa south to Tanzania, Asia Minor to Arabia, Iran, Transcaucasia, Turkmenia, India and Nepal (Honacki *et al.* 1982), but it has not been recorded from the countries east to the Bay of Bengal (Ellerman and Morrison-Scott 1966).

The hyena is included in Schedule III of the Wildlife (Protection) Act, 1972 amended in 1991. The species has declined rapidly due to habitat destruction and persecution by human beings and is thus declared 'Vulnerable' (Tikader 1983).

Koppikar and Sabnis (1976, 1977), Chakraborty and De (1995), De and Chakraborty (1995), Chakraborty *et al.* (1996, 1999) and De *et al.* (1998) worked on the trichotaxonomy of different Indian carnivores. For identification, very little information is available on skin derivatives as well as hairs of hyena, except for that given by Koppikar and Sabnis (1976).

Samples were collected from each of the following dry preserved specimens present in the National Zoological Collection of the Zoological Survey of India, Kolkata: 2 examples (1♂, 1♀, Sunder, Balaghat, Chhattisgarh); 2 examples (2♂, Zoological Garden, Kolkata).

De, J.K. & R. Chakraborty: *Hyaena hyaena* PLATE 1



Figs 1-4: Cuticular scale and medulla structure of dorsal guard hair of *Hyaena hyaena*,
1. Surface structure: 40x, 2. Surface structure: 1000x, 3. Medulla structure: 400x,
4. Medulla structure: 1000x

Five spots with a diameter of 5-7 mm, almost equidistant from each other, were selected at the mid-dorsal region and guard hairs collected with a fine forceps from each spot. During collection, very often the woolly hair would get mixed with the guard hair, which were sorted before processing them further. The sample size varied from 30-50 in number.

For macro- and microscopic studies, samples were washed in different grades of acetone or carbon tetrachloride. To study cuticular scales, a thin film of clear varnish was drawn on a microscopic slide and dry treated hair was put on it to get the cast, and allowed to dry for 8-10 hours. Before examination under the microscope, the hair sample was pulled off gently. To study the medullary structure, hairs were cut into pieces and treated separately with carbon tetrachloride for 4 hours and then mounted on glass slides with Canada balsam-xylol (70:30) solution. Detailed methodology is available in Chakraborty and De (1995) and Chakraborty *et al.* (1996).

Structural nomenclature of cuticular as well as medullary configuration was adopted from Moore *et al.* (1974) and Brunner and Coman (1974). Mean and standard deviation are mentioned in parenthesis.

The findings are summarized below:

A. **Physical Characters**

Colour: Seal brown at tip, paler towards root, cream-buff at base; *Total length*: 30-96 mm (60 mm ±25.5); *Diameter*: Apical: 30-80 μ (58μ ±15.36), Middle: 70-170 μ (118 μ ±32.49), Basal: 80-150 μ (113 μ ±34.94); *Shape and Nature*: Straight, banded, without shield, number of bands usually 2, but rarely 3.

B. **Surface Structure**

(Plate 1: Figs 1 & 2).

Scale Pattern: Irregular wave; *Scale Count*: 175-335 (295 μ ±0.22) per millimetre of hair length; *Scale margin distance*: Intermediate; *Scale margin*: Crenate; *Side to side scale length* (SS): 57.25-71.5 μ (64.26 μ ±5.04); *Proximo-distal scale length* (PD) : 1.8-13.9 μ (10.75 μ ±2.05).

C. **Medulla**

(Plate 1: Figs 3 & 4)

Medullary configuration: Simple unbroken cellular; *Medullary Index*: 0.56-0.59 (0.57 ±0.002)

D. **Cross section**: Elliptical

In recent years, trichotaxonomy has gained significance for identifying mammals. Hausman (1920) stated that hairs of *H. hyaena* have 'Imbricate-Crenate' cuticular scale structure, whereas Koppikar and Sabnis (1976) stated that "no scales are visible and the borders are plain". But our study reveals that there are well-developed cuticular scales in *H. hyaena*. Scale pattern is 'Irregular wave' and the scale margin is 'Crenate' (Plate 1: Fig. 1 & 2). Thus, we agree with Hausman (1920).

According to Hausman (1920), hairs of *H. hyaena* have continuous nodose medulla, whereas Koppiker and Sabnis (1976) observed that in the proximal and medial region the medulla is continuous, while in the distal region, it is fragmented. But our studies show that the medullary configuration is 'Simple Unbroken Cellular' (Plate 1: Figs 3 & 4) with medullary index, 0.57 ±0.002.

Colour, shape, nature, scale pattern, scale margin and scale margin distance of dorsal guard hairs of *H. hyaena* are almost identical in all the 4 specimens studied so far. It is also found that, the measurements of cuticular scales and medullary configuration and medullary index have a similar trend in all the specimens studied, but length and diameter of the same vary a lot.

Cross-sectional structure is elliptical, which is quite different from other carnivores studied so far, but in Mustelidae and Procyonidae

it is rather elliptical (Teerink 1991).

Medullary configuration and index, colour, shape, and nature, scale pattern, structure, margin and distance, cross-sectional structure may, therefore, be considered to identify *H. hyaena* using the dorsal guard hairs.

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4. THE STATUS OF GAUR *BOS GAURUS* IN NORTH CACHAR HILLS DISTRICT OF ASSAM

(*With one text-figure*)

The gaur *Bos gaurus* H. Smith is widely distributed in northeastern India. However, except for a survey in north Bengal (Bhattacharyya *et al.* 1997) and a status report from Dibang Valley district, Arunachal Pradesh (Choudhury 1999), no significant work on this bovine has been done in the region. The North Cachar Hills district (24° 59'-25° 49' N, 92° 31'-93° 28' E) of Assam is a known gaur area. During field visits between 1986 and 1997, information on the species, both past and present was gathered from the district. I report the findings here.

Till 1950s, the gaur was widespread and common all over the northern areas of the district. Stracey (1963) reported a large population with some majestic bulls in the same area. In the southern half, which is dominated by the lofty Barail Range (rising beyond 1,900 m above msl), the species was less abundant, possibly due to the mountainous terrain. In the northern areas, the main forest type is deciduous, while in the south it is evergreen. Topographically, the northern areas are rolling plateau while in the south the mountain slopes and cliffs are steep.

At present, a small number of gaur occur in the Langting-Mupa Reserved Forest (RF), (493.4 sq km) and in the Sarkihading Range in the north, and northeast respectively and Krungming RF (108.4 sq. km) in the northwest. One female calf was captured in Krungming RF in the early 1980s and sent to the Assam State Zoo at Guwahati. Stray animals still survive in the unclassed forests between Sangbar and Umrangsu (proposed Khorongma Wildlife Sanctuary), also in the northwest. In the main Barail Range, the gaur is no longer found, but stragglers are still met with near Laike, near the Assam-Nagaland border, Simleng river area in the southwest, and the catchment area of Jenam river towards the southeast. Stray individuals are occasionally met with in the basin of the Diyung river between Haflong and Dihangi.

The population in the northeast is contiguous with that of Dhansiri RF in Karbi Anglong and Intanki Wildlife Sanctuary in Nagaland (Choudhury 1997). Both these areas have a sizeable gaur population.

Table 1: Measurements (in cm) of horns of some gaurs examined in north Cachar Hills district

	Sp-1 (m)	Sp-2 (m)	Sp-3 (m)
Maximum spread	85.0	72.0	78.0
Tip to tip (span)	56.0	48.0	46.0
Sweep (across forehead)	-	-	158.0
Girth at base (maximum)	-	30.0	38.0
Maximum length of a single horn	-	-	63.0

Sp (specimen)-1: Upper Hmartlangmoi;
Sp-2: Lower Hmartlangmoi; Sp-3: Dihangi; m: male

The first major threat to the gaur came at the end of the 19th century when the hill section railway, between Lumding and Badarpur, was constructed, which divided the entire habitat into two. Along with the railway came hunters from outside. But the situation was not still bad, till the rinderpest of 1966, which took a heavy toll in Langting-Mupa RF and adjacent areas (Choudhury 1995). The population recovered to a great extent and in the 1970s, the species was 'common' at places although it could not reach its former abundance. New settlements had started coming up in many of the areas, including reserve forests, in the late 1970s followed by logging. The latter increased significantly in the 1980s, but took a menacing turn in the 1990s. Bulk of Langting-Mupa RF and adjacent unclassed forests suffered heavily, both due to logging as well as encroachment. A number of timber-based industries, especially sawmills, came up in many places like Maibong, Langting, Hatikhali, Mandardisa, Diyungmukh and other areas. These factors along with the local growth of human population have resulted in degradation and alteration of the habitat. Easy availability of firearms has resulted in increased poaching for meat as all the local tribes: the Dimasa Kacharis, Kukis (Hmars, Thadous, Biates, Rangkhawls Paites), Jemi Nagas, Jaintias and Karbis relish gaur meat. The gaur population declined drastically.

It is difficult to make an accurate population estimate as the animals are extremely shy due to regular persecution and are rather thinly distributed. However, after visiting all the known and potential areas and interviewing local hunters/poachers and other tribal villagers, it was generally estimated that 80-120 gaurs were there in Langting-Mupa RF in 1992-94 while 10-20 in Krungming RF in 1997. Elsewhere, 10-20 still survive in the unclassed forests between Sangbar and Umrangsu, 6-10 in the Jenam river basin,

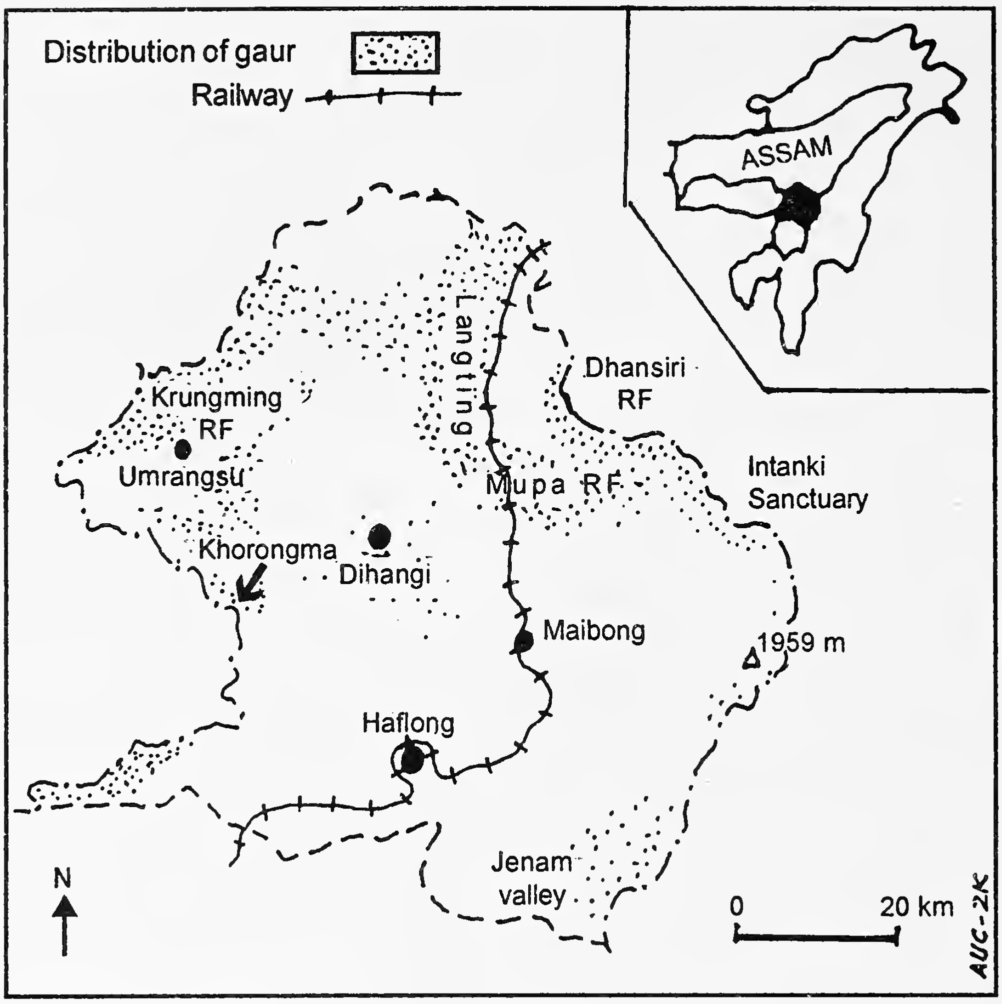

Fig. 1: Map of North Cachar Hills District, Assam showing the distribution of gaur

and a fluctuating population of 20-50 in Sarkihading Range. The last named area is contiguous with Dhansiri RF of Karbi Anglong district and Intanki Wildlife Sanctuary of Nagaland. In Dhansiri, a healthy population of a few hundred (up to 400) survives (Choudhury 1993, 1998) while a Forest department census in 1978 sighted 67 in parts of Intanki. In Simleng river, Laike areas and Diyung basin (Dihangi area) perhaps less than 20 survive. The population in Langting-Mupa RF will now be less than 100 as there is no sign of check on logging as well as hunting. The total habitat available for the species in the district is above 500 sq. km (Fig. 1).

Presence of domestic stock in the encroachments and 'Forest Villages' is a potential source of diseases like anthrax, foot-and-mouth, and rinderpest.

Habitat destruction and poaching with guns and rifles continue to be major threats, and unless conservation measures such as creation of protected areas and enforcement of the Wildlife (Protection) Act are taken, the future of the animal is bleak. The beginning of insurgency since mid-1990s all over the district has made the situation worse. Ultramodern arms such as the AK47 rifle are now available to the extremist guerrillas, and the Forest Department Officials are threatened. An unknown number of wild animals, including the gaur have been killed, mostly by the villagers and hunters/poachers while timber smugglers have a free run.

Part of Krungming RF, 'Khorongma' area, Sarkihading Range and parts of Langting-Mupa RF need to be brought under the protected area network once the situation improves.

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5. DISTRIBUTION AND STATUS OF THE GAUR *BOS GAURUS* IN NAGALAND

(*With one text-figure*)

The gaur *Bos gaurus* H. Smith is still widely and sparsely distributed in northeastern India, however, it is a rather poorly documented species. Except for a survey in north Bengal (Bhattacharyya *et al.* 1997) and some brief status reports (Choudhury 1992, 1993, 1995, 1999, 2001), no specific work solely for this species has been taken up in the region. Its distribution in Assam has been mapped recently (Choudhury 1997a). Here I report the past and present status of the species in the state of Nagaland (25° 10'-27° 01' N, 93° 17'-95° 15' E) (area: 16,579 sq. km) (Fig. 1) as ascertained during field visits in 1991, 1992, 1996 and 2001. The area was referred to in the past as the Naga Hills of Assam, as the entire area is hilly with small plains near Dimapur. The highest peak is Mt. Saramati (3,842 m above msl) on the India-Myanmar border. Mt. Japfu (3,043 m above msl) is the second and is on the Barail range. The lowest evaluation is in the riverbeds near Dimapur (less than 150 m above msl).

Some information on gaur in Nagaland is given in Choudhury (1997b). The current distribution of the species is mostly confined to Intanki Wildlife Sanctuary in Dimapur district. Some of the animals from this population also wander up to near Jalukie, Samjuram (both in Dimapur district), Peren and Tening (Henima) (both in Kohima district) (Fig. 1). Being located near the Assam-Nagaland border, the animals move freely between Intanki and Assam's Dhansiri Reserve Forest (Choudhury 1998) and also to the unclassed forests of Assam's North Cachar Hills district and occasionally to Manipur's Tamenglong district. Small numbers of gaur are thinly distributed in the forests along the India-Myanmar border in Tuensang, Mon and Phek districts. An occasional animal is encountered, mostly wandering from Assam, in the Singphan Reserve Forest of Mon district, which also share borders with Assam and Arunachal Pradesh. There are no recent reports from other districts, although a few survived in Mokokchung, Wokha and Zunheboto even in the early 1980s.

During field visits, I examined and measured 11 preserved horns (seven in the Forest Museum, Kohima; three in Samjuram village and one at Zunheboto) of the animals shot in different parts of Nagaland. Three of these were large. The measurements of some are listed in Table 1. The animal from Zunheboto was killed by local hunters in the foothills area of Saramati, Tuensang district in 1967. In 1938-40, villagers near Ajikami village in Akuloto sub-division of Zunheboto district killed a bull after it had injured some villagers. It reportedly came to mate with a semi-wild cow mithun *Bos frontalis* (S. Hukiye, pers. comm.).

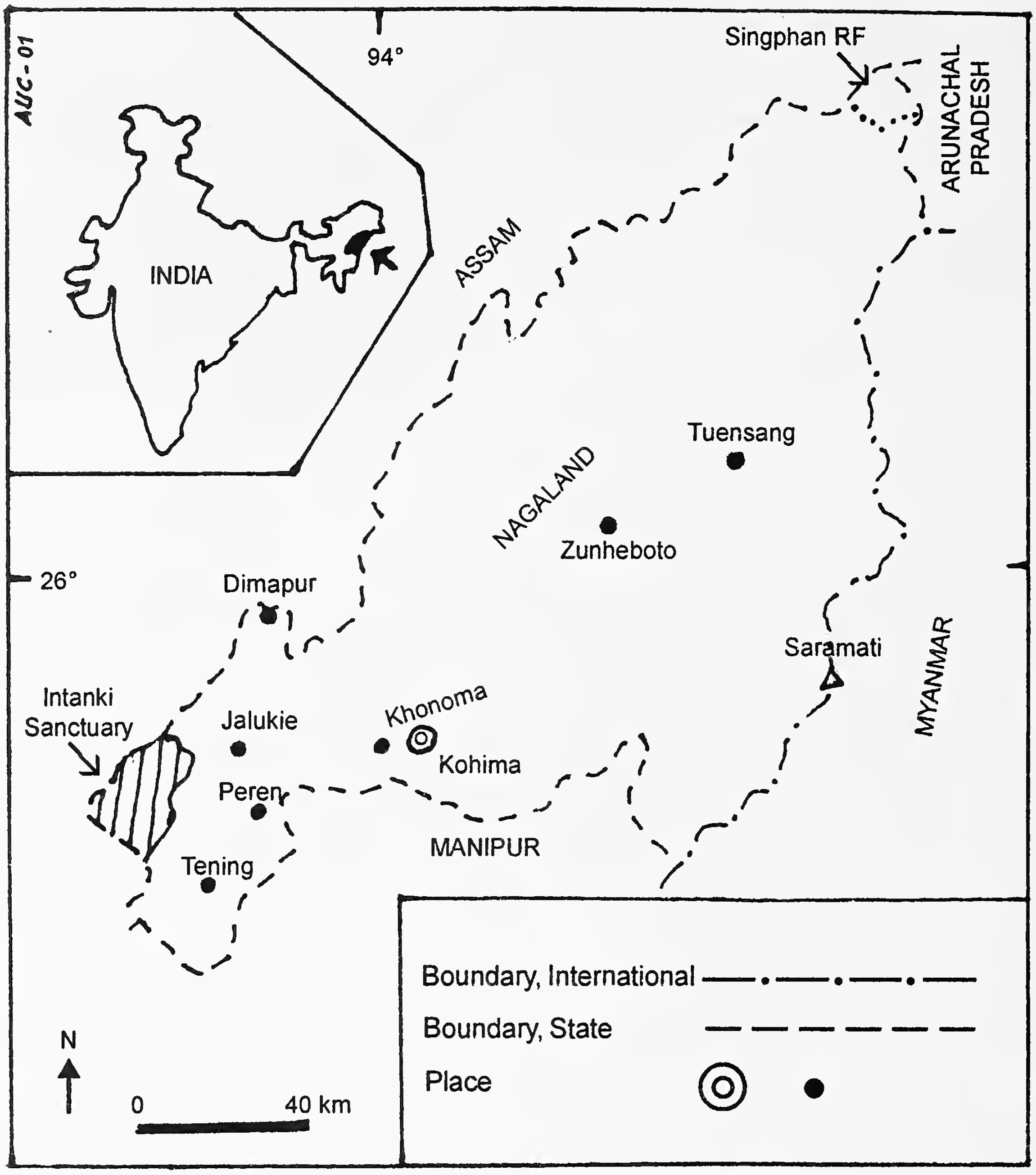

Fig. 1: Map of Nagaland showing the places mentioned in the text

In the Barail range stretch between Peren and Kohima, the gaur is not found now, save for stray animals. In the late 1980s, the hunters from Khonoma village had shot two in Dzukou area (T. Sakhire, pers. comm.). Around Peren, the gaur was not uncommon till the 1980s; now it is very rare. In 1999-2000, 4-5 came from the northwest (Intanki and adjacent areas). In February 2000, one was shot near Tening town. It reportedly came from the North Cachar Hills district of Assam (Huki, pers. comm.). In 1974-75, two were reportedly snared with a rope near Nkio village, near Tening. Both the horns are now with the Range Officer of Jalukie (I examined them). In 1981, a bull and a cow were shot near Samjuram village.

Poaching for meat was the main reason for the decline of the gaur from larger parts of Nagaland as its meat is relished. Destruction of habitat by felling for wet paddy cultivation (in Jalukie-Rangapahar areas) and *jhum* elsewhere was also a major factor. Although no specific record of large-scale occurrence of rinderpest could be found, perhaps there was casualty in 1966 in southwestern Nagaland when this dreaded disease took a heavy toll in the North Cachar Hills district of Assam (Choudhury 1995).

Table 1: Measurements of some gaur horns (in cm)

	Spread	Span (tip-to-tip)	Sweep across forehead	Girth (right horn)	Girth (left horn)	Length (right horn)	Length (left horn)	Skull Length
Specimen A: Forest Museum	100.0	68.5	186.5	51.0	52.0	75.0	73.5	59.0
Specimen B: Forest Museum	90.0	-	-	-	-	-	-	-
Specimen C: Zunheboto	92.0	47.0	-	-	41.0	-	-	-

It is generally estimated that less than 100 gaur are present in the Intanki Wildlife Sanctuary and adjacent areas. During a census in 1978, the Forest Department staff sighted 67 gaurs. With improvement in protection measures, the number will rise both due to local growth as well as movement from the Dhansiri Reserve Forest of Assam. In the latter area, a healthy population of a few hundred survives (Choudhury 1993). In the forests along the India-Myanmar border, some 20 to 30 may still occur. Elsewhere, less than 10 may be estimated as stragglers. The total habitat available for the species in Intanki and adjacent areas is about 250 sq. km.

It seems that the Intanki Wildlife Sanctuary is the only area where a viable gaur population could survive for long. Unfortunately, enforcement is virtually non-existent, while poaching, felling and encroachment threaten this protected area. Since it is the only potential area in the entire state of Nagaland where not only gaur but sizeable populations of elephant *Elephas maximus*, sambar *Cervus unicolor*, tiger *Panthera tigris* could survive, adequate protection must be given to the Sanctuary. Some adjacent forests should be added to increase its area from 202 sq. km to at least 300 sq. km and the Sanctuary should be declared a National Park — the first in the entire state. New guard posts with well-armed personnel and radio-network should be established. Intanki Wildlife Sanctuary has records of some other globally threatened species such as the marbled cat *Felis marmorata*, clouded leopard *Neofelis nebulosa* and the white-winged duck *Cairina scutulata* as well as the largest population of hoolock gibbons *Hylobates hoolock* in Nagaland. Presence of the Dhansiri Reserve Forest (770 sq. km) across the border in Assam is an added advantage for the gaur and other species of Intanki. Reported cases of poaching of the gaur and other animals should be dealt with firmly.

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6. ALBINO GAUR AT THE NAGARHOLE NATIONAL PARK, KARNATAKA

(*With one plate*)

On April 11, 2001, at about 0630 hrs, while going around Nagarhole National Park, in Kodagu district, Karnataka State, I spotted a herd of gaur *Bos gaurus* at a salt lick on the Chikkapala road. To my great surprise and wonder, an albino calf was moving in the herd. The sun had not risen, the day was cloudy and the light very poor. But fortunately, my camera had a 400 ASA film and 80-200 lens with f 2.8 aperture (Plate 1, Fig. 1), which helped me take several good pictures of the calf, even though the light was poor. The calf was entirely snow-white, and it was about six months old. I have been going to all the sanctuaries of Karnataka for the last three decades, but it was for the first time that I saw an albino gaur. My friends T.N.A. Perumal and Dr. S.R. Jayaprakash, both from Bangalore, and Arunthavaselvan T.R.A of Coimbatore were with me. It was a rare sighting worth recording.

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7. OCCURRENCE OF THE WILD WATER BUFFALO *BUBALUS ARNEE* IN MIZORAM AND MANIPUR

(*With one text-figure*)

The Asiatic wild water buffalo *Bubalus arnee* Kerr (*bubalis* Linn.) has become very rare all over its former range. It is common only in a few protected areas of Assam, e.g. Kaziranga, Manas and Dibru-Saikhowa. Information on the current status and distribution is given by Choudhury (1994). The species usually occurs in tall grasslands in the plains. However, its presence in the Balpakram National Park of Garo Hills, Meghalaya and adjacent areas (Choudhury 1994) has been a matter of curiosity as well as question. But it seems that the small grassy patches along the rivers and streams, in the depressions and on tableland in hilly areas, also harbour buffalo populations, apparently in lower density than the plains. After the Balpakram experience, I had reason to believe that the wild buffalo also occurred in other hilly regions of northeastern India in the recent past, although no documentation had been done. However, because of hunting pressure from various tribal groups, it has vanished from most such areas.

During a recent visit to Mizoram in February 2001, I came across a massive horn of a bull wild buffalo at a house in Aizawl city, the state capital. On enquiry, I came to know that it was collected from Vaitin, a village in Aizawl district, in far northern Mizoram (24° 12' N, 92° 58' E) (Fig. 1). The interstate border with Manipur is not far from the village, about 5 km only. The buffalo was reportedly shot around 1976 inside Manipur. The locality of shooting

Neginhal, S.G.: *Bos gaurus* PLATE 1

Fig. 1: Albino gaur at a salt lick on the Chikkapala road

was in Tipaimukh area of Churachandpur district, Manipur (*c.* 24° 12' N, 93° 00' E), not far from Vaitin. The villagers of both Manipur and Mizoram were aware of the presence of a few wild buffaloes in the area in the 1960s and early 1970s. This particular specimen was well known in Vaitin area of Mizoram and adjacent areas of Manipur till its death for its majestic horns, and it reportedly had a massive body. Its horns measured (in cm): maximum spread 152.0; tip-to-tip (span) 105.0; sweep across forehead 278.5; individual horn (right) 130.0; individual horn (left) 125.0; girth at base (right) 44.0; girth at base (left) 44.5. The conspicuous characteristic of the horns that I noticed was fewer curves.

The area where small numbers survived till the 1970s is near the confluence of the Tipai (Tuivai) river with that of the Barak. Along both these rivers, there were narrow grassy plains with tall reeds such as *Phragmites karka*, *Neyraudia reynaudiana*, *Arundo donax* and *Saccharum* spp., providing habitat for small numbers of wild buffaloes. The larger horn size of some domestic buffaloes in northeastern Mizoram and southwestern Manipur also indicates the occurrence of wild buffaloes in the area in the recent past.

There are no reports on the occurrence of wild buffalo in Manipur and Mizoram in the recent past (Choudhury 1994, Gee 1964, Stracey 1963). However, there are records from Hailakandi and Cachar districts of southern Assam, of which some sites were very close to northern Mizoram (Choudhury 2001) (see Fig. 1).

Poaching for meat by the Mizo, Kuki (including Hmars), and Paite tribes, was the main reason for the elimination of wild buffalo population in the area. Clearing for wet paddy cultivation in the narrow river valleys has also resulted in loss of habitat, which was already very small. This record confirmed that the wild buffalo existed in Manipur and Mizoram even in 1970s, but is now perhaps 'locally extinct' from these

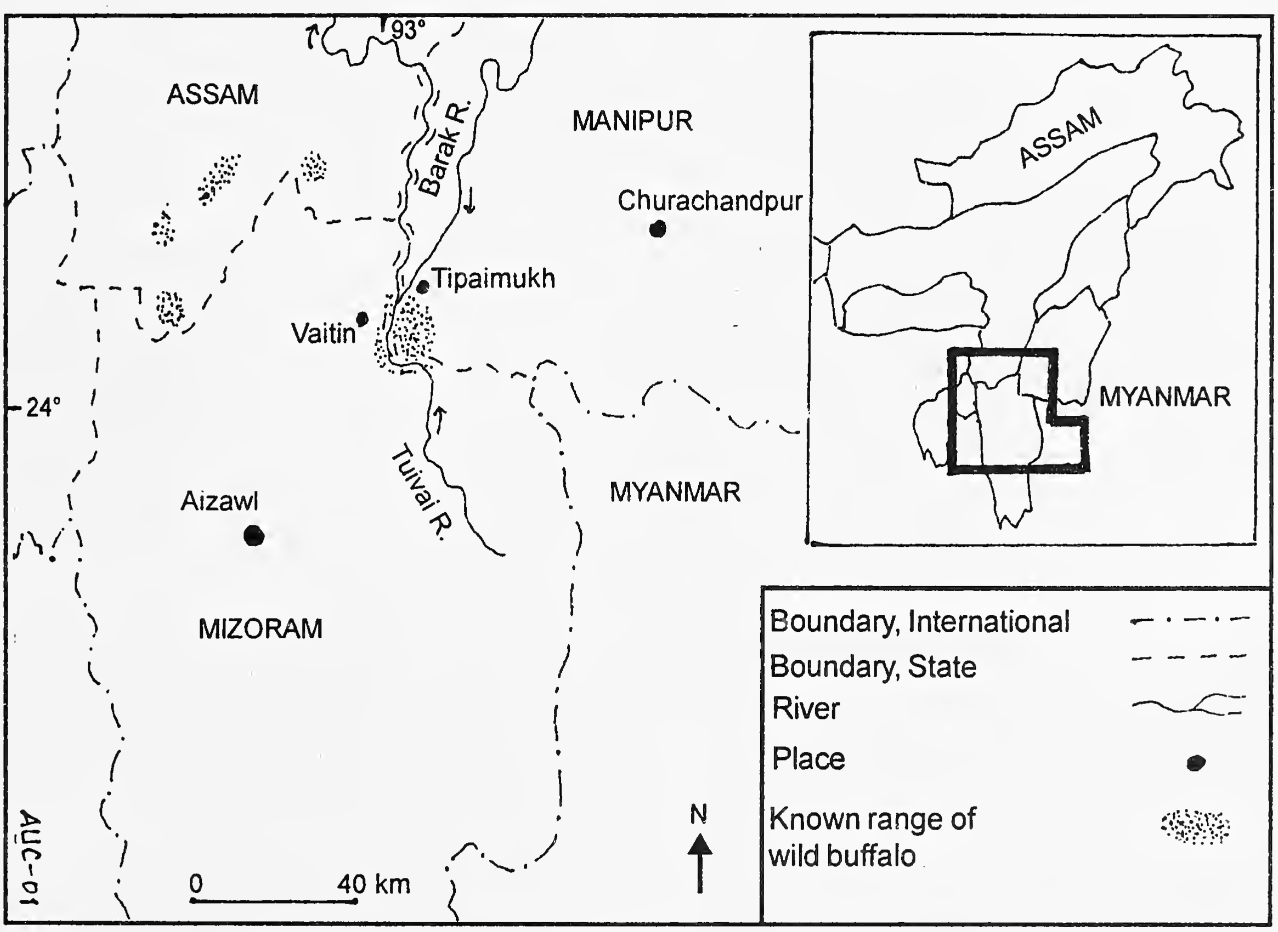

Fig. 1: Map showing the places mentioned in the text

two states.

I thank F. Sap Bawia, retired Deputy Registrar of Cooperative Societies, Mizoram, and his wife for help and also allowing me to examine and measure the horn, N.R. Pradhan (ACF) for helping to organise the field visit, and R. Sangkhama (Range Officer) and Hakeem for accompanying me.

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8. GREY HERON *ARDEA CINEREA* SCAVENGING ON CATTLE CARCASS

On January 1, 2000 at 1830 hrs while returning from a bird watching trip to Gangapur Dam, 14 km west of Nashik (Maharashtra), we saw 35 Indian white-backed vultures *Gyps bengalensis* roosting on two large mango (*Mangifera indica*) trees. As it was dusk, we could not investigate why the vultures were attracted to the mango trees. The next day, at 1600 hrs, we reached the same site. While approaching the mango trees, we saw 18 black kites *Milvus migrans migrans* circling low over a pair of cow carcasses 200 m ahead. There were also a number of house crows *Corvus splendens*, two Indian white-backed vultures *Gyps bengalensis* and three dogs feeding on the carcasses. Surprisingly, we also found a grey heron *Ardea cinerea* watching the carcasses from a distance of *c.* 40 cm. It began edging towards the carcass and then suddenly and swiftly came upon the kill, and tearing a chunk of meat moved 2 m away to feed on it. This is strange behaviour on the part of the grey heron, which normally feeds on fish, frogs, etc. (Ali and Ripley 1983). Snow *et al.* (1998) mentioned the food of grey heron as chiefly fish, amphibians, small mammals, insects and reptiles; occasionally crustaceans, molluscs, worms and plant material. Grey heron scavenging on a carcass in grasslands is quite unusual.

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9. ATTEMPT BY A CATTLE EGRET *BUBULCUS IBIS COROMANDUS* TO FEED ON AN ADULT HOUSE SHREW *SUNCUS MURINUS* (LINN.)

On March 17, 2000, around 1600 hrs, I heard the frantic squeaking of a house shrew *Suncus murinus* (Linn.) coming from the paddy fields adjacent to my house. A cattle egret was seen making vigorous attempts to catch something, which was not visible to me. On scanning the spot through my binoculars, I found to my utter surprise that it was a full grown house shrew, trying to escape. By then, the egret had somehow managed to catch the shrew. Then something went wrong and the shrew in a bid to defend itself got hold of the lower mandible of the egret in its mouth. The puzzled egret ran here and there, jerking its neck to free itself from the shrew. The egret had to work hard to free its beak. The shrew, though injured, escaped.

As per Ali and Ripley (1987), the food of cattle egret consists chiefly of insects and to a lesser extent of tadpoles, frogs and lizards, but there is no mention of any mammal species in its diet.

May 23, 2000

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10. OCCURRENCE OF NORTHERN SHOVELLER *ANAS CLYPEATA* LINN. IN KOLE WETLANDS OF THRISSUR, KERALA

The Kole wetlands in Thrissur district are one of the important wintering grounds for migratory birds coming to Kerala. The area lies between 10° 20'-10° 40' N and 75° 58'-76° 11' E, extending over about 11,000 ha. Kole wetlands are situated below sea level and paddy is cultivated during October to April, after draining the water. During monsoon (June to September) the whole area is inundated. As part of ecological studies on wetland birds initiated in 1998, we have been surveying the area regularly. During these surveys a flock of 28 northern shoveller *Anas clypeata* Linn. was recorded on December 15, 1999 along with a group of 1,656 garganey *Anas querquedula* (Bluewinged teal). Twenty individuals were sighted again in the same place on December 21, 1999, after which the birds were not sighted in the locality, because the area was drained for paddy cultivation.

Only a few sight records of the northern shoveller are reported from Kerala. Recently, Zacharias and Gaston (1993) have reported the species from Wynaad. Ali (1984) and Neelakantan *et al.* (1993) have not reported the species from Kerala and according to Zacharias and Gaston (1993), Ali omitted the species by error. This is the second area-specific report of the species from Kerala and also confirms the earlier observation of Ali and Ripley (1983) that the northern shoveller was found in small parties in association with garganey.

July 19, 2000

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11. BLACK-SHOULDERED KITE *ELANUS CAERULEUS VOCIFERUS* (LATHAM) PREYING ON WOOD SANDPIPER *TRINGA GLAREOLA* LINNAEUS

During our studies on wetland birds of Kole area in Thrissur district, we observed a black-shouldered kite *Elanus caeruleus vociferus* (Latham) capturing a wood sandpiper *Tringa glareola* Linn. from a paddy field on January 6, 2000. After capturing the prey the kite landed on a nearby bund. The sandpiper was alive and the kite tried to kill it. Observing through a telescope (20x) we saw the kite removing the feathers from the wings and feeding on the flesh and bones. It took 35 minutes to completely consume the prey. The wood sandpiper was caught from a flock of birds numbering around 50. The Kole wetland covering an area of 11,000 ha is spread over Thrissur and Mallapuram districts. The area lies between 10° 20'-10° 40' N, and 75° 58'-76° 11' E.

Lamba (1970) had reported black-shouldered kite catching a wounded green pigeon (yellow-legged green-pigeon) *Treron phoenicoptera* in flight. According to Ali and Ripley (1983), locust, grasshopper, crickets, other insects, lizards, field rats, mice, young and sickly birds are the recorded food items of the black-shouldered kite. Its feeding on migratory species like the wood sandpiper is not reported so far and this is an addition to its list of prey.

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12. LEAF-PRESENTING AS POSSIBLE COURTSHIP BEHAVIOUR BY PIED FALCONETS *MICROHIERAX MELANOLEUCOS*

Pied falconets *Microhierax melanoleucos* (Blyth) are distributed from the foothills of the eastern Himalaya through southern China, Laos and northern Vietnam. Despite this wide range, rather little is documented about their breeding behaviour, and Grimmett *et al.* (1998) comment that the juvenile remains undescribed. We present here incidental observations of behaviour apparently connected with breeding, made during a trip to Northeast India in 1998 (Hornbuckle *et al.* 1998).

A small group of at least four pied falconets *Microhierax melanoleucos* was observed on the top of a tall, open tree near the Deban HQ of Namdapha National Park, Arunachal Pradesh, on February 24, 1998 at *c.* 0800 hrs. JH observed one with a large leaf in its bill, which it proceeded to offer to a neighbouring bird. This bird accepted

the leaf in its bill, but soon dropped it and neither bird made any attempt to retrieve it. The other birds, perched a little further away, soon flew off, as did the presenting bird a few minutes later. Shortly after, DA also saw this behaviour reenacted on some dead, bare branches in the canopy of probably the same tree. At least one falconet was seen flying with a large leaf (*c.* 15 cm long) held in its feet, before alighting on a bare branch. It transferred the leaf to its bill and presented it to another bird, which then dropped the leaf almost immediately.

Three weeks later, on March 12, in the Kolomi area of Dibru-Saikhowa Wildlife Sanctuary, Assam, DA saw two pied falconets land on the top of a dead tree and again witnessed this unusual behaviour.

Presenting of food items as a courtship ritual is well known among raptors (Cade 1982); moreover, leaves are used by several species as nest material. However, the presenting of leaves seems to be very unusual.

The first record of this kind of behaviour is by Naoroji (1997) who observed the courtship behaviour of collared falconets *Microhierax caerulescens* on April 16, 1993. He commented that, prior to mating, there would be an extended courtship ritual in which the female would usually remain perched on a bare branch while the male would fly off. Prior to returning, the male would often pluck a dried sal leaf with his feet and deposit it in the nest hole, sometimes perching alongside the female with the leaf before depositing it in the nest.

Pied falconets are recorded as breeding in old barbet and woodpecker holes from March to May (Delacour and Jabouille 1931, Ali and Ripley 1987). Caldwell and Caldwell (1931) remark that (in China) the eggs are laid 'upon a bed of leaves and bits of grasses in a cavity of a tree.' However, Baker (1935) while noting that their nesting behaviour was poorly known, recorded only beetle elytra and other insect remains as nest lining. Etchecopar and Hue (1978-83) also refer to the nest being of insect remains, while Delacour and Jabouille (1931) state that the eggs always lie on a bed of insect debris, beetle elytra and butterfly wings. Neither they nor La Touche (1931) or Baker mention any leaves being present in nests of pied falconet, though Baker comments on leaves in the nest holes of the collared falconet. This is puzzling, since the behaviour we observed would seem to be stereotyped.

At 0923 hrs on March 15, in Panbari Forest near Kaziranga National Park, PIH observed two pied falconets perched together about 20 m up a tree on a dead snag. The pair was about 20 cm apart, with the female facing away from the male. He was bobbing from an exaggerated vertical position to the horizontal about once per second, and calling frantically. This was a fairly loud, very excited, rapid-fire sequence of slightly hoarse, chattering notes – '*jiff jiff jiff jiff jiff....*' which gradually slowed, and reminded PIH of the food-begging calls of fledglings of several other raptor species. This behaviour continued for a few seconds, after which copulation occurred, with the male continuing to call for about 20 seconds afterwards. The pair then flew off. This was a rather brief observation by PIH, and neither leaf-presenting nor clumping and allopreening, (thought by Naoroji to help maintain the pair bond of collared falconets), were seen.

Closely perched collared falconets were noted by Sparks (1965) to often face away from each other in captivity, probably to prevent agonistic responses.

Our observations are presumably earlier in the breeding cycle than those witnessed by Naoroji, but suggest that pied falconets may show some similarities in courtship and mating behaviour to collared falconets. The offering of leaves, presumably by the male, may be a first stage in initiating interest in mating and nesting behaviour in the female.

Kemp and van Zyl (1998) recorded collared falconets breeding cooperatively. Etchecopar and

Hue (1978-83) note that pied falconets can be seen in groups of 5 or 6, and this together with our observation of a group at Deban in February suggests that pied falconets may also sometimes breed cooperatively. Clearly this species, regarded as 'Vulnerable' by BirdLife International (Collar *et al.* 1994), requires considerable further study.

November 25, 2000

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13. UNUSUAL ASSOCIATION BETWEEN A PAIR OF SARUS CRANES *GRUS ANTIGONE* AND SIBERIAN CRANE *GRUS LEUCOGERANUS* AT KEOLADEO NATIONAL PARK, BHARATPUR

A strong bond was observed between a pair of sarus cranes *Grus antigone* Linn. and a female Siberian crane *Grus leucogeranus* Pallas during 1997-98. It was first observed in September 1997, a few days after the two captive bred Siberian cranes left the Park and one died. Four captive bred Siberian cranes had been released in the Park during February 1997, as part of an International effort to augment the dwindling population of Siberian cranes.

The lone female Siberian crane, Baharami, foraged in block F in the northeast region of the Park and a pair of sarus was regularly seen in the same block. Baharami gradually started feeding with the sarus without evoking any agonistic reaction from them, and by the second week of September she had also started roosting with them. They would roost just a few feet away from each other. The cranes vocalised, displayed, foraged and roosted together as a close-knit flock by early October. The sarus cranes would threat-display if their conspecifics attacked Baharami and would chase them away. They would even attack the wild Siberians if they tried chasing Baharami. An approaching dog or man would elicit loud unison calls and the two sarus cranes would alert each other. Most of the time, at least one of the three cranes would look around while

feeding, probably keeping watch for predators. Baharami would also show agonistic behaviour on the approach of perceived threat, and would threat display with widespread wings and stabbing action. She would try to come between the sarus cranes and the threat, and would shield them with spread wings. Baharami continued to remain in the company of the sarus even after the two released Siberian cranes — Annber and Alkonost — had come back to the Park during December 1998. She continued to display, vocalise and fly with the sarus. Baharami would even go for some time into the neighbouring wheat field with the sarus and would attempt to feed. She would, however, come back and spend time in a lake in the Park near the Park wall. She would respond to their unison call and would join them as soon as they came back. Probably due to her food preference, she did not forage in the wheat fields. Siberians are known to feed exclusively within the jheels and rarely leave water (Sauey 1985).

After February, the sarus started going outside the Park to forage in the agricultural fields. Initially, Baharami would go with them, but she stopped joining them after some time. However, she would immediately go towards them when they returned to the Park. This association continued till the last week of May 1998, when the sarus cranes left the Park due to adverse ecological conditions.

Usually, the sarus does not tolerate the presence of Siberians and chases them away. Sauey (1985) found the presence of sarus to be the most serious disturbance factor, second only to human presence. During the present study, similar observations were recorded, except for this pair of sarus. Sauey (1985) states that the interactions are usually intense where the feeding territory of Siberian and breeding territory of sarus overlap. However, some unattached sarus roost in a flock with Siberians, as there is no clash of interest.

Probably, the pair of sarus were young, still unmated and had not established territory. They did not breed in the following breeding season of 1998 and were observed nesting unsuccessfully during 1999. So, they formed a flock with Baharami, who was still a young two-year-old female. Young and females are usually more tolerated by congenerics (Sauey 1985).

Close association between birds of either sex has been reported between congenerics, when they flock together (Viess 1982), but we have not come across any report of a pair of a species developing a close association with a congeneric individual. Variation from normal behaviour is expected from captive-bred individuals, but the sarus were wild. Hybrids have been recorded between congenerics during a release programme (Brown 1992), but they are considered the undesirable fallout of experimental conditions.

March 31, 2000

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14. OBSERVATIONS OF SQUATTING POSTURE ADOPTED BY *CHLAMYDOTIS UNDULATA* (JAQUIN)

(*With one plate*)

As is well known, the houbara (*Chlamydotis undulata*) is a species inhabiting open spaces with light ground cover from where it can see all round. It is alert and wary, preferring to trust its legs to escape from danger. However, it takes to its wings when hard pressed. At times, it squats low and freezes on the ground to escape detection. Before doing this, the bird warily walks on, moving the head and neck backwards and forwards a few times, and then suddenly squats down flush with the ground behind a clump of grass, other vegetation or next to a stone, and sometimes on the bare ground where from a distance it appears like a lump of dried-up cattle dung. Some authorities state that while taking up this posture to hide, the houbara stretches out its neck along the ground. Be that as it may, I have observed this behaviour many times, but never have I seen this species stretch its neck out along the ground. All the individuals I had seen freezing folded their neck backwards towards the body with their neck and head pressed down almost between the shoulders.

Considering the practical aspects of this instinctive behaviour, if a bird were to stretch its neck forward, the colour of the neck, being lighter than that of the upper parts of the houbara's body, would be quite conspicuous and so would not escape the sharp vision of a predator, particularly a raptor, whereas the neck bent backwards towards the body provides better camouflage. Besides, it would not be convenient or easy for an individual to crawl along the ground in a crouching position, as this bird often does, with an outstretched neck. While squatting doggo against a clump of vegetation, the houbara constantly keeps it sharp, wary eye on the pursuer and moves round, keeping the clump between itself and the intruder, whereas with a raptor hovering above it keeps absolutely still. I have observed the same habit of squatting low in *Ardeotis nigriceps* and *Sypheotides indica.*

April 20, 2000

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15. A BREEDING COLONY OF RIVER TERN *STERNA AURANTIA*, SMALL PRATINCOLE *GLAREOLA LACTEA* AND RED-WATTLED LAPWING *VANELLUS INDICUS* AT LONAVLA

INS Shivaji at Lonavla in Maharashtra has a sprawling 400 hectare campus surrounded by hills of various heights. The hillocks around the plain campus were instrumental in creating a draining basin or rivulet. An artificial lake of about 1 sq. km with an islet of approximately 400 sq. m has been created by bunding the rivulet. The islet cannot be approached by any means and it is submerged in water during the rainy season from June to September every year.

About 500 river terns *Sterna aurantia* breed on the islet in the company of small pratincoles *Glareola lactea* (100-120 individuals) and red-wattled lapwings *Vanellus indicus* (150-200 individuals). On enquiring, we were told that they are breeding on the islet since the early 1980s. In the evening of March 3, 2000, we observed hundreds of them incubating their eggs, some of them chasing invading crows.

During the monsoon months when the islet is submerged under water, the birds with their

Himmatsinhji, M.K.: *Chlamydotis undulata* PLATE 1

M.K. RANJITSINHJI

Fig. 1: The sqatting posture seen above is more likely to be adopted by a houbara in the wild

chicks roost on the adjoining high grounds and some of them move to occupy the bank of the Tata Lake near Lonavla town.

ACKNOWLEDGEMENT

We are grateful to Cdr. Ramesh Babu of INS Shivaji for conducting us through their Eco-park, including the lake and islet, and for more information on the breeding terns described in this note.

February 6, 2001

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16. RUDDY TURNSTONE *ARENARIA INTERPRES* LINN. AT PHULERA LAKE, RAJASTHAN

On September 5, 1999 we were at Phulera Lake, Jaipur district, hoping to see some early migrant birds. The first glimpse of the lake was not very promising, as the lake was dry. Rather disappointed, we decided to proceed to Sambhar Lake. Nevertheless, before leaving, H.S.S. decided to have a look at the few birds on the lake. While scanning the birds, he noticed a ruddy turnstone *Arenaria interpres* Linn.

The bird was on the northern side of the lake, where part of the lake bed is covered with small stones. This part of the lake is usually inundated, but that year it was almost dry, save for one extremely shallow patch of water.

The bird was a male in breeding plumage with distinctly patterned black and white upper parts and extensive orange-brown on scapulars and wing coverts. We observed the typical feeding method for more than 10 minutes before it flew away. In flight, its bold white wing bar and elongated white patch on the back, and white upper tail coverts were clearly seen.

There are not many inland records of the ruddy turnstone in the Indian subcontinent. According to Ali and Ripley (1980) there are 'very few definite records of overland migration in India'. They describe it as an 'exceptional vagrant inland'. Roberts (1992) writes that it has not been sighted on inland freshwater bodies in Pakistan. Ali and Ripley (1980) mention records of the species from Lucknow (Uttar Pradesh) Patna (Bihar), Sambhar Lake and Bharatpur (Rajasthan) and Manipur in the last 95 years. However, it has also been recorded from Najafgarh near Delhi (Ganguly 1975) and Harike in Punjab (Robson 1997). Our sighting of the species at Phulera is an addition to the existing inland records.

June 9, 2000

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17. OCCURRENCE OF THE INDIAN SKIMMER *RHYNCHOPS ALBICOLLIS* SWAINSON IN ASSAM

The Indian skimmer *Rhynchops albicollis* Swainson is resident in the Indian subcontinent, ranging from Pakistan, North and Central India (not recorded south of *c.* 16° N) and east through Nepal and Bangladesh. Subject to local migration, depending on water conditions, populations of the bird have declined during the last few decades and it is now considered globally threatened (Collar *et al.* 1994).

On November 27, 1999, S. Rochelle (a tourist from the USA) and I were out on a jeep safari in the Kohora (Central) Range of Kaziranga National Park (26° 35'-25° 45' N and 93° 05'-93° 40' E). At about 1210 hrs, while passing through Mona Beel (a perennial oxbow lake), I saw two tern-like birds settle among a group of common teal *Anas crecca* along the side of the wetland. The birds appeared to have dark wings and looked strikingly different from the ubiquitous river tern *Sterna aurantia.* After driving along the beel for a few hundred metres while the sun was behind us, I stopped to take a closer look. On observation through a pair of 10x binoculars and a 20x telescope, I noted the following characteristics:

A long-winged bird about the size of a crow (larger than the river tern of which there were several nearby) — dark blackish-brown wings projecting beyond the tail; black crown and nape contrasting with white forehead; white sides of neck forming a white collar; rest of underparts glistening white; large red beak with the lower mandible longer than upper; legs red. I recognized the birds as Indian skimmers, the pied plumage and beak being distinctive of the species.

The birds were seen at the same place the following day and they remained in the area till December 2, 1999. T. Gullick and E. Stanford (birdwatchers from Spain and the UK respectively) were among others who had also seen the birds.

The status of the Indian skimmer in Northeast India is poorly known. Ali and Ripley (1981) mention that the bird affects the placid expansive reaches of rivers with sandbanks, and include the Brahmaputra river system in its range. However, there have been no recent records of this species from the region. In their more recent work, Grimmett *et al.* (1998) have excluded Assam from its range. In December 1998, B.N. Talukdar (Assistant Conservator of Forests, Assam State Forest Department) and I surveyed *c.* 700 km (the course of the Brahmaputra in Assam is 720 km) stretch of the Brahmaputra river, from Dhubri (Indo-Bangladesh border *c.* 90° E) to Oriamghat (Assam-Arunachal Pradesh border *c.* 95° E), but could not find any skimmers. The habitat along the river was found to be highly disturbed (more so west of Guwahati) and chances of the river supporting any skimmer population is slim. I have not come across this bird during my seven years of bird watching in the Kaziranga National Park, nor has there been any other record (Barua and Sharma 1999). Hence, this record is noteworthy.

I would like to thank Rishad Naoroji, Dr. Asad R. Rahmani and B.N. Talukdar for all their help.

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18. BLUE ROCK PIGEONS FORAGING ON TAMARIND LEAVES

On April 9, 2000 I was observing birds in my garden when I noticed four blue rock pigeons *Columba livia* flying into a tamarind (*Tamarindus indica*) tree. As I observed them, I was surprised to see them plucking at the tender newly sprouted tamarind leaves. Initially I thought they were just plucking at the leaves, but on a closer look I saw that they were eating the young leaves. Tamarind leaves are sour to taste. It is difficult for me to tell whether it was the taste of the leaves that had attracted the blue rock pigeons or whether they were eating them for fibre.

This is the first time in my 20 years of bird watching that I have seen blue rock pigeons foraging on tender tamarind leaves.

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19. UNUSUAL NESTING MATERIAL IN THE NEST OF BLUE ROCK PIGEON *COLUMBA LIVIA* GMELIN

The blue rock pigeon *Columba livia* is one of the most common birds in the urban environment of Hyderabad (Andhra Pradesh). It breeds throughout the year and nests near human habitations on rafters, in corners of ceilings among other places. I have noticed many nests in the twin cities of Hyderabad and Secunderabad on roof tops, window sills, apartments, and places of worship, made entirely of twigs, leaves and feathers.

During May 1999, I made an interesting observation on the nesting behaviour of the blue rock pigeon in my hostel building at Secunderabad. On May 22, 1999, I came across a pair of blue rock pigeons bringing nest material into my room. The nest was being built on top of an almirah, a regular nesting site of pigeons. At 0630 hrs, the half built nest was seen to be made up of dried neem leaves, twigs, feathers, roots, grass and dried pods of *Acacia.* After two hours, I was surprised to see ten black hairpins, a ring, a black hair clip, and a bangle, all made of black metal, and a key ring, bottle top, and three pink aluminium bangles, in the nest. All these items except the bangle had been picked up from my table while I was away. It is interesting that the birds preferred metal items. The birds were found in the nest for two days before they abandoned it. Another abandoned nest, with six pink bangles, a black hair clip and fifteen black hairpins was found on May 3, 1999.

There have been notes on the peculiar nesting habits of urban dwelling birds. Lamba (1963) and Alterogi and Davis (1976) described extensively the urbanization in the nest building of house crow *Corvus splendens splendens* in various cities. Lamba (1968) has reported a wire nest of red-vented bulbul *Pycnonotus cafer*. This shows that the rapid changes in the urban environment affect the nesting behaviour of birds.

July 10, 2000

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20. ORIENTAL TURTLE-DOVE *STREPTOPELIA ORIENTALIS*: A NEW SPECIES FOR THE THAR DESERT

While conducting surveys for diurnal raptors near Bikaner, Rajasthan we sighted an Oriental turtle-dove *Streptopelia orientalis* at Kodamdesar near Gajner on October 4, 1999. The bird was observed drinking water at 1715 hrs with about 15 Eurasian collared-dove *Streptopelia decaocto* from a puddle near the village water tank. The bird was immediately distinguishable by its stocky pigeon-like build. Its reddish-brown scaly patterned back, chessboard like spots on each side of the hind neck and dark tail, edged with white, looked quite striking compared to the uniformly plain Eurasian collared-dove.

The species is not listed in the checklist of the birds of the Thar Desert of Rajasthan, which summarises the bird records of three surveys between February 1993 and May 1994 (Rahmani 1997). H.S.S. has been regularly visiting the Thar since 1986, but has never come across this species before (Sangha 2002). This is the first record of the species from the Thar Desert to the best of our knowledge. Ali and Ripley (1981) write that this dove avoids 'semi desert tracts' and give northern and peninsular India as its wintering range. Grimmett *et al.* (1998) and Kazmierczak (2000) do not mention this area in the distribution of this species.

Although this is the first record for the Thar Desert, it is not unexpected. The development of the Rajasthan Canal (Indira Gandhi Nahar) and its feeder channels in the Thar Desert, have transformed the landscape to a considerable extent. Extensive plantations along the canals, increase in irrigated crop fields, and development of waterbodies due to seepage along the canals has increased the avian diversity in the area and many species that were not recorded earlier have become common.

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21. BREEDING RECORD OF THE SYKES'S NIGHTJAR *CAPRIMULGUS MAHRATTENSIS* (SYKES) IN HARIKE, PUNJAB, INDIA

The Sykes's nightjar *Caprimulgus mahrattensis* is listed as a rare resident and winter migrant in India (Grimmett *et al.* 1998). Its breeding in India has been recorded in Kutch (Abdulali and Hussain 1971), while it is suspected to breed in Punjab, Saurashtra and Rajasthan (Ali and Ripley 1987, Grimmett *et al.* 1998).

On May 1997, two chicks of the Sykes's nightjar were located on the bank of River Satluj in Harike, Punjab. The overall appearance of the adults was light sandy/greyish; the head was not streaked heavily as in other *Caprimulgus* species; and the white spots on the outer primaries were clearly visible in flight. The iris was darkish brown with white bristles over the gape. The birds sometimes gave a continuous churring or purring call at dusk. The identity of the birds was further confirmed by comparing the photographs taken with the specimens in the collection of the BNHS.

The nest was located on a sand bank under a sparse *Tamarix* bush (*c.* 60 cm), approximately 2 km downstream of the Harike Barrage. The nest was observed for three days during the early mornings and late evenings. The parents were observed brooding with their wings spread during the hot hours of the day. The chicks could not be located at the nest site after the third day. However, the adults stayed on in the vicinity of the nest for another five days, and occasionally did the broken-wing display, indicating the presence of chicks in the area. This is the second confirmed record of the Sykes's nightjar breeding in India, and the first for Punjab, and is worth recording.

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22. SIGHT RECORDS OF THE SAND MARTIN *RIPARIA RIPARIA* IN SOUTHERN INDIA

On February 11, 1998, on a birdwatching trip to the Nellore district of Andhra Pradesh, I came across a congregation of over 100 sand martins *Riparia riparia* flying low over the lush green paddy fields. They were hawking insects in the company of other swallows and flew around uttering *Cherr-Cherr* calls. I am quite familiar with these sand martins as I have seen them on several earlier occasions in the neighbourhood of Madras (now Chennai) (Santharam 1985), near Kaliveli Tank (Santharam 1987), Sullurpetta marshes on the Sriharikota Road and also at Kavaratti Island, Lakshadweep (Santharam *et al.* 1996). Details of these sightings are presented in Table 1. However, this recent sighting is perhaps most noteworthy as it had the largest numbers present to date. The site was located in the vicinity of Pennakki Village Tank, off the Gudur-Kota road.

The sand martin can be easily told apart from common swallows (*Hirundo rustica*), with

Table 1: Sight records of sand martin *Riparia riparia*

Date	Location	No. of birds
11.iv.1980	Adyar Estuary, Madras	1
12.x.1980	Adyar Estuary, Madras	1
19.x.1980	Adyar Estuary, Madras	1-2
10.xii.1980	Adyar Estuary, Madras	1
31.iii.1985	Adyar Estuary, Madras	15-20
26.x.1986	Kaliveli Tank (near Pondicherry)	2
11.ii.1988	Kaliveli Tank (near Pondicherry)	2-3
06.ii.1990	Sullurpet Marshes (Nellore Dt., Andhra Pradesh)	8
29.x.1990	Kavaratti Island (Lakshadweep)	1
31.x.1990	Kavaratti Island (Lakshadweep)	1
27.xii.1997	Sullurpet Marshes (Nellore Dt., Andhra Pradesh)	3-4
11.ii.1998	Pennakki, (Nellore Dt., Andhra Pradesh)	100+
27.ii.1998	Pallikaranai Marshes, (outskirts of Madras)	10-15

which it often appears to associate, from its size and colouration. It is smaller than the swallow and lacks the long tail feathers. The colouration is distinctly dull, being grey-brown and white in contrast to the glossy steel-blue and pinkish-white of the common swallow. Besides, the sand martin has the grey-brown breast band, which can be easily noticed, even in overhead flight. On a previous occasion, while watching the birds perched on low *Calotropis* bushes at the Adyar Estuary, I could make out that the ear coverts and wings appeared darker, and a faint white mark (arc-shaped) was noticeable over the eye in most of the birds. Their legs were brown and the bill dark in colour.

According to the HANDBOOK (Ali and Ripley 1983), this species is confined to northern India. It is said to be "widely but sporadically distributed; partly migratory, partly resident; subject also to considerable local movements, as yet little understood". It has been recorded in the Maldives in small numbers, usually between September and November and once in May (Phillips 1963, Strickland and Jenner 1977). All of my sightings have been between October and April.

I am sure the sand martin is commoner in Southern India than it is believed. Possibly, it is often overlooked among flocks of swallows. I hope this note will induce other readers to look out for this bird in their locality, especially in winter.

According to the BIRDS OF THE INDIAN SUBCONTINENT (1998) by Grimmett *et al.*, the sand martin has recently been split into two species — pale martin (*Riparia diluta*) and sand martin (*Riparia riparia*) based on minor colour variations and calls. The former has greyer upper parts and less distinct breast band. The birds I had seen had quite distinct breast bands and were more brown in colouration, and hence were presumably *Riparia riparia*.

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23. POSSIBLE NEW RECORD OF *STURNUS MALABARICUS BLYTHII* IN VALSAD DISTRICT, GUJARAT

Atul Ltd. lies about 80 km south of Surat (Gujarat) and 200 km north of Mumbai, in Valsad district, Gujarat (South). It is a wellknown, large industrial complex for the manufacture of chemicals of colours, dyes and pesticides. On August 15, 1999 between 0630 hrs and 0830 hrs, we visited Atul Limited to survey a heronry located in the complex. We recorded 9 species of water birds in the heronry, and 20 or 21 other species in the whole complex.

We observed quite a large number of birds of genus *Sturnus* under the roofs of the factory sheds, where steel columns were being used as their roosting sites. Flocks of different sizes were leaving the complex for their foraging sites when we reached the complex early in the morning.

Our attention was drawn to the different species in the flocks of mynas. They were cheeping noisily perched on the canopy of one of the beef wood trees *Casuarina equisetifolia* in the complex. We observed them for at least half an hour, before they flew away to the west towards the estuary of the Par river. They were smaller in size and sleeker in body shape than the other mynas, and had conspicuous whitish head and neck.

Through our binoculars, the body appeared overall grey on the upper parts, and on the underparts there was rufous on the belly and flanks, with a contrasting bright white head, nape, neck and breast area. With the help of the COMPACT HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (second edition) and BIRDS OF THE INDIAN SUBCONTINENT, we confirmed that the species we saw was the white-headed subspecies *blythii* of the grey-headed starling *Sturnus malabaricus*.

We counted a total of 75-80 birds of *Sturnus malabaricus blythii* in a single flock, along with 1,000+ common myna (*Acridotheres tristis*), 100+ bank myna (*Acridotheres ginginianus*), 40-45 Brahminy myna (*Sturnus pagodarum*) and 20-25 rosy starling (*Sturnus roseus*).

The occurrence of 75-80 individuals is the largest number of *S. malabaricus blythii* recorded from Gujarat in recent years. Dr. Sálim Ali, during his survey of the birds of Gujarat (*JBNHS* 52: 374-458, 735-802, 1954-1955) had collected one specimen of *S.m. blythii* from Ajwa-Vadodara district. There are two other published references on the occurrence of this subspecies from Gujarat. B.M. Parasharya and S.N. Varu (see page 531 of this issue) report that this subspecies is a regular visitor to Gujarat. They believe that one recorded nesting by M.K. Himmatsinhji might also be *S.m. blythii.*

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24. *STURNUS MALABARICUS BLYTHII* IN GUJARAT STATE

The white-headed subspecies *blythii* of the grey-headed starling *Sturnus malabaricus* was recently sighted at a few places in Gujarat State. One bird was observed feeding on sorghum (*Sorghum bicolor*) grains from a standing crop at Anand during February 1992 (BMP). On June 10, 1996, 50+ birds were observed feeding on ripened fruits of neem *Azadirachta indica* at Kevdi village on the outskirts of Ratanmahal Wildlife Sanctuary (BMP). One pair was observed regularly entering a cavity of a mahua *Madhuca indica* tree on July 13, 1999 at Jambughoda Wildlife Sanctuary. The pair may have been engaged in breeding activity.

One of us (SNV) had seen a single bird in April 1980 in the Gir Forest. On March 28, 1999,

one bird was recorded at Loriya Village of Bhuj tehsil, Kutch.

At least three specimens of *S.m. blythii* have been collected from Gujarat. During his bird survey of Gujarat, Dr. Sálim Ali collected a specimen on October 29, 1945 at Ajwa, Vadodara district (Ali 1954). In the BNHS museum, there are two specimens one collected from Ajwa, Vadodara district and another from Valsad district (Abdulali 1978). Ali and Ripley (1983) mentioned that one specimen of this subspecies was collected from Ahmedabad too, however, they did not refer to Ali (1954) or to Abdulali (1978). Recently, Patel *et al.* (1999) observed 70-80 birds of *S.m. blythii* on August 15, 1999 at Atul, Valsad. (see page 531 of this issue)

Earlier, Himmatsinhji (1970) recorded four *Sturnus malabaricus* near Mandvi, Kutch and a nesting pair near Wankaner (Surendranagar district). However, he did not specify the subspecies. His description of the female of the nesting pair indicates that it might be *S.m. blythii.* Without naming the subspecies, Monga and Naoroji (1984) reported 30 birds near Timba, 75 km north of Vadodara. They have also reported a nesting pair in June near Vadodara. Mehta *et al.* (2000) had observed 400-500 birds every April between 1980 and 1984 in the Gir Forest (subspecies not mentioned). None of the specimens of *S.m. malabaricus* was collected from Gujarat (Abdulali 1978).

There are very few sight records of this species from Gujarat during the last 55 years. Dharmakumarsinhji (1954) in BIRDS OF SAURASHTRA did not list the species. It is never seen regularly anywhere in Gujarat, indicating seasonal movement (Ali and Ripley 1983, Grimmett *et al.* 1998). Two nesting records from Gujarat (present report and that of Himmatsinhji) are noteworthy. It is evident that the distribution of *S.m. blythii* given by Ali and Ripley (1983) and Grimmett *et al.* (1998) needs revision. The species that occurs and also breeds in Gujarat is *S.m. blythii.*

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25. HOUSE CROW *CORVUS SPLENDENS* VIEILLOT FEEDING ON MIDGES

On June 24, 1999 at around 1830 hrs while walking along the embankment of the Hussain Sagar lake (constructed in 1660-70, in the twin cities of Hyderabad and Secunderabad to supply drinking water to the people during the reign of Ibrahim Qutub Shah), we observed unusually large swarms of the midge *Kiefferulus* spp. (Diptera: Chironomidae) everywhere along the lake bed. Interestingly, about 12-15 house crows (*Corvus splendens splendens*) were seen feeding voraciously on these insects, pecking at them one by one from the pavements. Within a minute, the crows had consumed about 140 insects. Even though it was dusk, the crows continued to feed till 1915 hrs.

The house crow is a known scavenger and takes practically everything that can be eaten. Ali and Ripley (1983) recorded many insects including winged termites, grasshoppers, beetles, ants and moth larvae in their diet. But nowhere have midges been reported on their menu.

Chironomids are well known as bioindicators of water quality. The larvae or blood worms were commonly reported from Hussain Sagar (Chandrasekhar 1998). They play a primary role in accumulation and transmission of contaminants in the eutrophic lake. Chironomid larvae function at a fundamental level in the aquatic food chain as the natural diet for fish, diving ducks and for other aquatic insects.

Despite their non-biting habit, the midges are reported to be involved in human allergic diseases causing bronchial asthma, conjunctivitis, hay fever, seasonal rhinitis and skin hypersensitivity. The midge larvae may often serve as mechanical carriers of pathogens from polluted water, e.g. *Legionella* causes bronchopneumonia in humans (Chaudhari and Chattopadhyay 1997). Apart from these health hazards, the swarms are a nuisance to two wheeler traffic. A very large roost of house crows was seen near the lake on a tamarind tree. The good lighting and availability of easy prey provided these flying municipal workers to operate during twilight hours.

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26. SIGHT RECORD OF THE LITTLE PIED FLYCATCHER *FICEDULA WESTERMANNI* SHARPE IN ANDHRA PRADESH

Pittie (1986) reported the first sighting of the little pied flycatcher *Ficedula westermanni* Sharpe from the Narsapur forest (17° 45' N & 78° 17' E) in Andhra Pradesh. On Nov. 10, 1997, while birding on the Gundla Brahmeshwaram Plateau (Eastern Ghats, at 775 m above msl) in the Gundla Brahmeshwaram Metta Wildlife Sanctuary located south of the Nagarjunasagar-Srisailam Tiger Reserve (15° 53'-16° 42' N; 78° 30'-79° 28' E), I saw a small bird with black upper plumage and white underparts, white wing patch, a long, broad, white supercilium and the sides of tail white near the base. The bird was later identified as the little pied flycatcher. The specimen could not be photographed as my colleague with the camera was some distance away and by the time he reached the site the bird had disappeared!

According to Ali and Ripley (1983), this species winters up to Surguja and is a frequent visitor along well-wooded streams. Earlier records in Andhra Pradesh are also along a well-wooded stream (Pittie *pers. comm.*). The individual I sighted was on a teak (*Tectona grandis*) tree near the Forest Rest House about 150 m from the Gundlakama river that originates a short distance away.

Prabhakar *et al.* (1994) reported its presence in the Western Ghats, particularly from the Nilgiri Biosphere Reserve. The bird recorded by me was most likely a winter vagrant and a new record of the species for the Eastern Ghats in Andhra Pradesh.

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July 5, 2000

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27. BLUE-THROATED FLYCATCHER *CYORNIS RUBECULOIDES* VIGORS IN THE THAR DESERT

On October 6, 1999 at Kishangarh, Jaisalmer district near the Indo-Pak border, we noticed a flycatcher in a *Prosopis chilensis* tree at the Border Security Force (BSF) outpost. The bird (not more than 3 m away) was immediately recognized as a male blue-throated flycatcher *Cyornis rubeculoides* Vigors. It was making typical aerial sorties to swoop on insects, returning each time to a different perch. We observed and photographed it over a period of two hours from 1450 to 1700 hrs.

The bird was an adult male with dark blue upperparts including exposed portions of wings and tail. A contrasting azure patch was quite prominent on the lesser wing-coverts. The forecrown, ear coverts and throat were dark blue. The throat looked almost black when the bird was perched in the shade. Demarcation of the

blue throat from the orange-rufous breast and pectoral region was distinct. The belly and vent were white, washed with buff. The bill was black with visible rectal bristles.

According to Ali and Ripley (1996) it winters in scattered areas, in the hills of southern India to Belgaum southwards to Kerala, Tamil Nadu, the Eastern Ghats, Bihar, Orissa, West Bengal, the plains and foothills of Bangladesh and southern parts of Sri Lanka. Grimmett *et al.* (1998) describe the distribution and status as breeding in the Himalayan foothills from Pakistan (Margalla hills) east to Arunachal Pradesh, and northeast India, wintering in East Himalayan foothills, south to Bangladesh, southwest India and Sri Lanka, with scattered records from elsewhere in India. Both these works do not record the species from the Thar desert and Rajasthan. However, there is one recent record from Rajasthan (Robson 1997). A blue-throated flycatcher was recorded by Paul Holt at Bharatpur in February 1996. Our sighting at Kishangarh constitutes the first record of the species from the Thar desert and the second from Rajasthan.

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28. UNUSUAL BEHAVIOUR OF PURPLE SUNBIRD *NECTARINIA ASIATICA*

On a routine visit to the Lingambudhi lake and its surroundings, I happened to witness unusual activity of the purple sunbird *Nectarinia asiatica* (Latham).

The purple sunbird, in breeding plumage, was perched on an *Acacia leucophloea* tree. On the same branch, a small bee-eater *Merops orientalis* Latham was also present at a distance of about half a metre. Both were simultaneously taking off, presumably after invisible insects, and occupying the same place after every sortie. After some sorties, the sunbird sat by the side of the bee-eater and started picking up something from the rump and under tail of the bee-eater. I could not make out what the sunbird was pecking at. This continued for 5-6 minutes.

Then the sunbird started pulling the tail feathers of the bee-eater. The disturbed bee-eater now showed its unhappiness by turning its head towards the sunbird and opening its beak as if to scare it away. This action prompted the sunbird to move off the branch, but it continued pulling at the tail feathers by hovering over the bee-eater.

The bee-eater changed its position to avoid this annoyance, but the sunbird would not relent. Unable to withstand the continued disturbance, the bee-eater chased the sunbird out of my view.

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29. SIGHTINGS OF ORTOLAN BUNTING *EMBERIZA HORTULANA* AT THE GRASSLAND AROUND GANGAPUR, NASIK

The Gangapur Dam, 14 km west of Nasik, in Maharashtra, is surrounded on all sides mostly by grasslands and crop fields of wheat, harbara, tomato and cabbage. *Heteropogon contortus*, *Cynopogon martinii* and *Dichanthium annulatum* are the three major grass species of the grassland.

The grassland is the major habitat for wintering buntings, namely the grey-necked bunting *Emberiza buchanani*, black-headed bunting *Emberiza melanocephala* and red-headed bunting *Emberiza bruniceps*. They have been regularly observed in large flocks for the last four years between October and March in the grasslands and cultivated lands.

Some of the other wintering migrants seen in large numbers are the greater short-toed lark *Calandrella cinerea* (now *C. brachydactyla*), yellow wagtail *Motacilla flava*, citrine wagtail *Motacilla citreola* and common swallow *Hirundo rustica*.

On November 19, 1997 while we were photographing a flock of buntings, seven buntings, which looked different from the above mentioned three species landed in a semi-ploughed field. On close observation, we saw the yellow moustachial streak extending to the hind neck, the prominent grey head, yellow throat and breast and the yellow eye-ring, which tallied with the description of the Ortolan bunting *Emberiza hortulana*. The birds were photographed, and the photographs sent to the BNHS and confirmed as those of the Ortolan bunting.

The birds were seen around the same area till February 1998. The sighting of this species in Nasik is not only the first record for Maharashtra, but also an authentic record for India after 27 years. The last record for India was at Delhi in 1970 (Jackson and Gaston 1972). This species has been sighted regularly in subsequent seasons in small numbers at the same site by the bird watchers of the Nature Conservation Society of Nasik. Hence, the status of this species in India could be changed from 'vagrant' of Ali and Ripley (1983), to an uncommon winter visitor.

ACKNOWLEDGEMENTS

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30. SIGHTING OF THE ROCK BUNTING *EMBERIZA CIA* LINN. IN RANTHAMBORE NATIONAL PARK, RAJASTHAN

Ranthambore National Park, an area of 392.5 sq. km, is located between 25° 54' - 26° 12' N and 76° 23' - 76° 36' E in the southeastern part of Sawai Madhopur district, Rajasthan. The

average elevation of the Park is 350 m above msl. The temperature fluctuates from 48 °C in summer to as low as 2 °C in the winter. During the rainy season, which extends from July to September, the Park receives about 800 mm of rainfall. It has a Mixed Dry Deciduous and Thorn Forest, predominantly comprising of *Anogeissus pendula*. The following observation was made during a 17-day trip to the Ranthambore National Park in January 2000.

Ali and Ripley (1987) recorded three subspecies of the rock bunting *Emberiza cia* — the Himalayan, the Tibetan and the Transcaspian. The Himalayan subspecies *E. cia stracheyi* is restricted to the Western Himalaya, through Kashmir and Nepal. The Tibetan subspecies *E. cia khamensis* is found in southeastern Tibet, northern Arunachal Pradesh, Bhutan, Sikkim and eastern Nepal. Interestingly, the Transcaspian subspecies *E. cia par* is known to exist all the way from the NWFP, Ladakh, Lahul and Spiti (summer grounds) to Punjab foothills (below 600 m), Ambala (Haryana), Delhi and Dehra Dun (wintering grounds). There is also a mention of a specimen from Varanasi (Benares, Uttar Pradesh). All the three subspecies are known to be common wherever they exist.

I saw a pair of *E. cia*, in all probability *E. cia par* (Transcaspian subspecies), the paler of the three subspecies, on two separate occasions in Ranthambhore on 20th and 23rd January, 2000 respectively. On both instances, it was seen in the evening in open grassland interspersed with *Anogeissus pendula* and *Acacia* sp. In fact, a pair was once seen along with a flock of white-capped buntings *E. stewarti*. The lateral black crown stripes and the bluish-grey throat of the male *E. cia* easily distinguish it from *E. stewarti*, which has an uniform grey crown with a conspicuous black throat patch. While *E. stewarti* winters regularly in many parts of Rajasthan, the range of *E. cia* within Rajasthan is unknown.

Grimmett *et al.* (1999) and Kazmierczak (2000) have shown the species in Maharashtra in the distribution maps without giving specific references. These are interesting records, and in case we consider them bonafide, the bird should also occur along the corridor that links Maharashtra to its summer grounds in Himachal Pradesh and Ladakh. In the light of such an assumption, it is not improbable to find the bird in Ranthambore (east Rajasthan) during winter, when the birds, in a bid to escape the severe cold, scatter from their breeding grounds situated in the higher reaches of the Himalayas. The sighting invites us to investigate its distribution in other regions of Rajasthan and Madhya Pradesh.

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31. FRUIT AND NECTAR RESOURCES IN A MOIST DECIDUOUS FOREST AND THEIR USE BY BIRDS — A PRELIMINARY REPORT

It is important to identify key plant resources used by wildlife to effect conservation and management actions (Kannan and James 1999). While there have been extensive studies on frugivory and nectarivory and on related aspects like seed dispersal and pollination abroad, very little is known about these topics in our country, but for a few studies e.g. Rajasekhar

(1995); Karthikeyan (1996); Thirumurthi and Banumathi (1998); Santharam (1996a, b); Athreya (1996) and Shahabuddin (1993) and references therein.

In this note, I report some findings on the use of fruit and nectar resources by birds in the Peechi-Vazhani Wildlife Sanctuary in Thrissur district, Kerala, which were made between September 1991 and May 1993 while studying the ecology of woodpeckers. The data is limited and may be treated as preliminary findings. I have concentrated mainly on species other than *Ficus* and *Bombax* which are well known as the major sources of fruits and nectar respectively, and attract the greatest number of bird species (Ali and Ripley 1983, Athreya 1996).

I kept notes on the flowering and fruiting of the more common and conspicuous plants in the Moist Deciduous Forest and the teak *Bombax ceiba* plantation at five 10 ha plots in the Peechi-Vazhani Wildlife Sanctuary. All the sites were within 100 m elevation. No data was collected during the peak of the monsoon (June-August). Birds visiting the trees for foraging on nectar and fruits were noted at all available opportunities.

The flowering/fruiting schedules of the important 'bird' plants are given in Table 1, which shows that there is a tendency for the nectar and fruit resources to be available more in the dry months (January-April). Most plant species offer fruits or nectar for short periods of two months or less, with the exception of the *Ficus* spp. and mistletoes (*Loranthus*). In both these cases, several species are clumped together and hence the pattern of longer availability with short gaps.

Data on the various bird species that visited different plants offering fruits and nectar is presented in Table 2. This lists 12 plant and 43 bird species from 10 and 16 families, respectively. Twelve of the birds listed were seen feeding on nectar alone, 22 only on fruits while nine species were observed feeding on both fruits and nectar. Members of three families, Dicruridae, Dicaeidae and Nectariniidae consumed nectar alone. Six species of woodpeckers were found feeding on both nectar and fruits.

Table 1: Flowering/fruiting phenology

Plant species	Month								
	S	O	N	D	J	F	M	A	M
Nectar									
Bombax ceibia (Bombacaceae)				x	x	x	x		
Bombax insignae (Bombacaceae)			x	x					
Careya arborea (Lecythidaceae)							x		
Helicteres isora (Sterculiaceae)	x	x							
Firmiana colorata (Sterculiaceae)							x	x	
Loranthus spp. (Loranthaceae)		x			x			x	x
Fruits									
Sterculia guttata (Sterculiaceae)					x	x			
Lannea coromandelica (Anacardiaceae)								x	
Macaranga peltata (Euphorbiaceae)							x	x	x
Cleistanthus collinus (Euphorbiaceae)					x				
Persea macrantha (Lauraceae)					x	x			
Zizyphus oenoplia (Rhamnaceae)				x	x				
Grewia tilaefolia (Tiliaceae)	x							x	x
Dillenia pentagyna (Dilleniaceae)								x	x
Ficus spp. (Moraceae)			x		x	x	x	x	x

Table 2: Plants visited by birds for nectar/fruits

	Plant Species											
Bird Visitors	1	2	3	4	5	6	7	8	9	10	11	12
Columbidae												
Pompadour green pigeon (*Treron pompadora*)							✓			✓		
Yellow-legged green-pigeon (*Treron phoenicoptera*)										✓	✓	
Green imperial-pigeon (*Ducula aenea*)					✓			✓		✓		✓
Emerald dove (*Chalcophaps indica*)		✓										
Psittacidae												
Plum-headed parakeet (*Psittacula cyanocephala*)				✓		✓	✓				✓	
Indian hanging-parrot (*Loriculus vernalis*)		✓	✓	✓		✓	✓				✓	
Cuculidae												
Asian koel (*Eudynamys scolopacea*)					✓			✓				
Capitonidae												
Small green barbet (*Megalaima viridis*)					✓			✓				
Picidae												
Little scaly-bellied green woodpecker (*Picus xanthopygaeus*)	✓						✓					
Small yellow-naped woodpecker (*Picus chlorolophus*)							✓		✓			
Lesser golden-backed woodpecker (*Dinopium benghalense*)		✓				✓	✓	✓				
Yellow-fronted pied woodpecker (*Dendrocopos mahrattensis*)							✓					
Heart-spotted woodpecker (*Hemicircus canente*)											✓	
Greater golden-backed woodpecker (*Chrysocolaptes lucidus*)							✓					
Oriolidae												
Eurasian golden oriole (*Oriolus oriolus*)		✓	✓			✓	✓		✓			
Black-headed oriole (*Oriolus xanthornus*)	✓											

Table 2: Plants visited by birds for nectar/fruits (*contd.*)

	Plant Species											
Bird Visitors	1	2	3	4	5	6	7	8	9	10	11	12
Dicruridae												
Ashy drongo (*Dicrurus leucophaeus*)		✓										
White-bellied drongo (*Dicrurus caerulescens*)		✓										
Spangled drongo (*Dicrurus hottentottus*)	✓			✓								
Greater racket-tailed drongo (*Dicrurus paradiseus*)	✓	✓										
Sturnidae												
White-headed starling (*Sturnus malabaricus blythi*)		✓		✓		✓	✓					
Common myna (*Acridotheres tristis*)		✓					✓					
Jungle myna (*Acridotheres fuscus*)							✓					
Common hill-myna (*Gracula religiosa*)								✓				
Corvidae												
Indian treepie (*Dendrocitta vagabunda*)		✓					✓		✓			
House crow (*Corvus splendens*)							✓					
Irenidae												
Gold-fronted chloropsis (*Chloropsis aurifrons*)		✓		✓								
Jerdon's chloropsis (*Chloropsis cochinchinensis*)			✓	✓								
Asian fairy-bluebird (*Irena puella*)		✓			✓		✓	✓	✓	✓		
Pycnonotidae												
Grey-headed bulbul (*Pycnonotus priocephalus*)									✓			
Ruby-throated bulbul (*Pycnonotus melanicterus gularis*)							✓			✓		
Red-vented bulbul (*Pycnonotus cafer*)		✓					✓		✓	✓		
White-browed bulbul (*Pycnonotus luteolus*)							✓					

Table 2: Plants visited by birds for nectar/fruits (*contd.*)

	Plant Species											
Bird Visitors	1	2	3	4	5	6	7	8	9	10	11	12
Muscicapidae												
Jungle babbler (*Turdoides striatus*)		✓										
Oriental magpie-robin (*Copsychus saularis*)					✓		✓					
Pied thrush (*Zoothera wardii*)								✓				
White-throated thrush (*Zoothera citrina cyanotus*)					✓		✓	✓	✓			
Blackbird (*Turdus merula*)					✓			✓	✓			
Paridae												
Great tit (*Parus major*)							✓					
Dicaeidae												
Plain flowerpecker (*Dicaeum concolour*)		✓										
Nectariniidae												
Purple sunbird (*Nectarinia asiatica*)			✓	✓								
Little spiderhunter (*Arachnothera longirostra*)		✓										
Ploceidae												
Yellow-throated sparrow (*Petronia xanthocollis*)							✓					
Total	4	16	4	7	7	5	22	9	8	6	4	1

Plant species codes: 1. *Careya arborea*, 2. *Helicteres isora*, 3. *Firmiana colorata*, 4. *Loranthus* spp., 5. *Sterculia guttata*, 6. *Lannea coromandelica*, 7. *Macaranga peltata*, 8. *Persea macrantha*, 9. *Zizyphus oenoplia*, 10. *Grewia tilaefolia*, 11. *Dillenia pentagyna*, 12. *Cleistanthus collinus*

Macaranga peltata attracted the greatest number of birds (22 species), followed by *Helicteres isora* (16 species) and *Persea macrantha* (9 species). A few other plant species not included in the list which also attract birds are: *Clitoria ternatea* - 7 bird species, many of which consume floral parts as well as nectar (Santharam 1997); *Albizia odoratissima* - which flowers in April, attracting several sunbirds that feed on its nectar; *Erythrina* and *Lantana* also attract several birds.

Even without accounting for other bird species that could be seen on *Ficus* and *Bombax* and several other plants, the present study based on casual notes revealed that nearly 40% of the forest avifauna consumes nectar and / or fruits

in a Moist Deciduous Forest of the Western Ghats. This list does not include several typical frugivores and nectarivores and so the actual figure could be much more — 50% or more of the species. The reason for this food habit is the presence of a large number of plants that produce nectar and fleshy fruits in the tropics that are adapted for bird and mammal consumption (Howe and Smallwood 1982). For instance, in the Dry Evergreen Forests of southeastern India, 72% of the native woody plants possess fleshy fruits (Narasimhan *et al.* 1993), which can be eaten by birds.

A critical study of the dispersal patterns of seeds, their germination rates and level of seed predation could determine how dependent these plants are on birds as well as other mammalian agents for their dispersal and survival. These, in turn, could indicate the conservation priorities in the Moist Deciduous Forests.

Some interesting observations were made on the foraging behaviour of some birds, feeding on the arillate seeds of *Sterculia guttata* from the dehisced follicle. Many of these fruits were present on terminal branches and access was possible only by hovering. At least three of the seven bird species (Oriental magpie-robin *Copsychus saularis,* Asian fairy-bluebird *Irena puella* and white-throated ground thrush *Zoothera citrina cyanotus*) feeding on this tree were seen hovering to pick the seeds. The white-throated ground thrush was found to be more arboreal in its feeding habits than is suggested by its name. It visited four tree species besides *Ficus* spp. for fruits and also fed on the nectar of *Bombax ceiba,* often about 15 m from the ground.

Acknowledgements

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32. *CLEOME SCAPOSA* DC., CAPPARACEAE — A RARE SPECIES FOR SAURASHTRA

(*With one text-figure*)

While surveying the vegetation of Saurashtra University Campus, Rajkot, Saurashtra, Gujarat an interesting species of *Cleome* was observed near a puddle of stagnant rainwater in a small colony and in isolation on gravelly sandy soil. On critical examination, the specimen was identified as *Cleome scaposa*, a species reported earlier by Shah (1978) as occurring in Saurashtra. However, it has been not documented by Thaker (1910), Santapau (1962), Santapau and Janardhana (1967) and, Bole and Pathak (1988). Its habit and habitat with a brief description and illustration is given here.

Cleome scaposa DC. Prodr. 1: 239, 1824; Fl. West Pak 34: 30, 1973.

Herb, annual, 10-18 cm tall. Slender, erect, unbranched, hairy with glandular hairs. Leaves simple, suborbicular to ovate-elliptic, scabrous; petiole 5-15 mm long, ciliate hairy; upper leaves almost subsessile. Inflorescence raceme lax, elongated, increasing up to 14-15 cm in fruit,

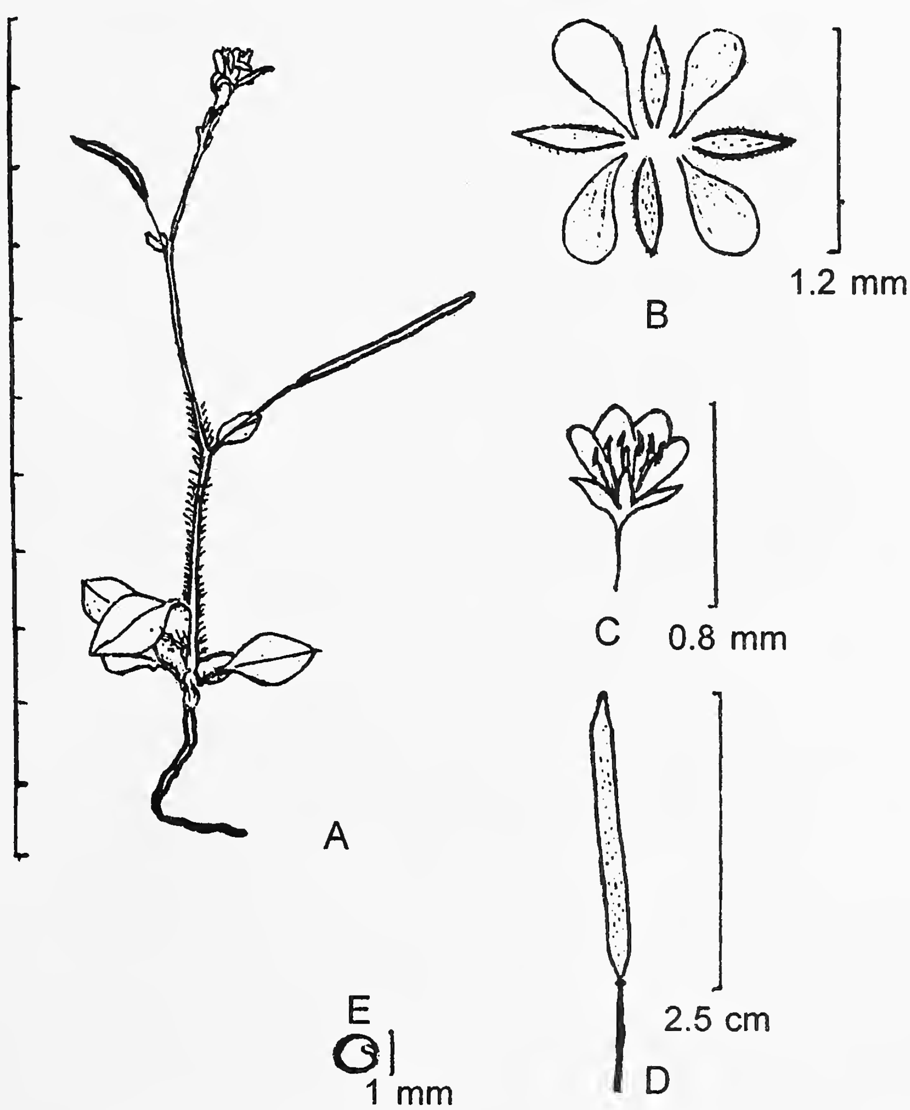

Fig. 1: *Cleome scaposa* DC.; A. Habit, B. Sepals and petals, C. Flowers, D. Fruit, E. Seed

filiform, ultimately spreading. Sepals elliptic hairy, pubescent. Petals oblong-obovate, yellowish. Stamens 6, about as long as petals, not exserted. Capsule linear, slender, 1.5-3 cm, often spreading and accurately curved, glabrous or slightly glandular, many seeded, style minute; seed glabrous, minutely granular, brown black.

Fl. & Fr.: July-September.

Present status: Very Rare.

Habitat: Gravelly, sandy, soil near water bodies.

Specimen examined: PSN 891a.

March 29, 2001

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33. OCCURRENCE OF *HIBISCUS RADIATUS* CAV. (MALVACEAE) IN PUNJAB

During November 1999, some fruiting plants were observed growing in a wasteland at Patiala. In 2000, the specimens were gathered while flowering and fruiting, and the species identified as *Hibiscus radiatus* Cav. This species has not been reported earlier from Punjab (Sharma 1990, 1994). Further, in the most recent work on the Malvaceae of India (Paul 1993), its range of distribution has been recorded from several states, but not from any state of northwest India including Punjab. Apparently, it is a new introduction to the flora of Punjab State. Brief information about the specimen collected is given below.

Hibiscus radiatus Cav. Diss. 3: 150.t.54.f.2. 1787; Masters in Hook f. Fl. Brit. India 1: 325. 1874; Paul in Sharma and Sanjappa, Fl. India 3: 327.f.90.1993.

Description: Erect undershrub, up to 1.5 m tall. Stems covered with long simple hairs and bulbous-based retrose prickles, ultimately glabrescent. Leaves 3-15 x 1.5-12 cm, palmately 3-5 (-7)-lobed nearly to base; lobes variable, linear to lanceolate, ovate to oblong or obovate, coarsely or sharply serrate, acute to acuminate, glabrous or with stout hairs on veins beneath; petioles 2-15 cm long, unarmed or sparsely aculeate; stipules 5-8 mm long, linear, bristly. Flowers solitary, axillary, showy, 5-6 cm across, purple with a darker centre; pedicels up to 2.5 m long, jointed, pubescent below the joint. Bracteoles (epicalyx – segments) 8 or 10, 1.5-1.8 x 0.15-0.2 cm, linear, acute, forked at apex, covered with bulbous-based bristles 1-2 mm long, often with an appendage on the inner side towards apex. Calyx 1.8-2 cm long, accrescent and stiff in fruit; lobes ovate to deltoid, long – acuminate, glabrous inside, bristly outside. Petals obovate, sparsely hairy outside. Staminal tube 1.5-2.2 cm long with laxly arranged anthers throughout. Ovary 5-7 mm long, globose, white-hirsute; style-arms purple; stigmas capitellate, dark purple. Capsules 2-2.5 x 1.2-1.5 cm, ovoid, shortly beaked, bristly, longitudinally 5-valved. Seeds 4 mm across, scabrous, brown.

Notes: The species under report belongs to the section *Furcaria* characterized by prickly stems, linear to lanceolate bracteoles forked at

apex and prominently 3-veined calyx-lobes. Within this section, this species is likely to be confused with the closely allied species *H. aculeatus* Roxb. (syn. *H. furcatus* Roxb.) because of prickly petioles and pedicels, non-foliaceous stipules and similar flowers. However, the latter species is a rambling or trailing undershrub which has undivided leaves or if leaves 3-5-lobed then lobed up to about middle only, ovate-lanceolate stipules and smaller fruits (1.2-1.5 cm long). Further, there are two important features in which the description given here differs essentially from the one given by Paul (1993) who describes pedicels 2-4 mm long and flower yellow with dark purple centre. However, in both these features the description given above matches with the one provided by Cooke (1958, pedicels 0.5-1 inch long) and Masters (1874, corolla yellow with a crimson centre or all purple).

Fl. & Fr.: September-December.

Illustration: Paul (*loc. cit.*)

Material examined: Urban Estate, Patiala; coll. M. Sharma 16669, 16670 (PUN).

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34. EXTENDED DISTRIBUTION OF TWO RARE AND ENDANGERED TAXA FROM TIRUNELVELI HILLS, WESTERN GHATS, TAMIL NADU

During plant explorations in the Kalakad-Mundanthurai Tiger Reserve (KMTR), Tamil Nadu, special attention was given to relocate the rare and threatened taxa, which resulted in the relocation of two species namely *Memecylon flavescens* Gamble (Melastomataceae), and *Ilex denticulata* Wall. ex Wight (Aquifoliaceae) (Henry *et al.* 1978, Nair and Henry 1983, Nayar and Sastry 1990, Sivarajan and Mathew 1996). They were critically studied in the Botanical Survey of India, (MH), Coimbatore. The specimens are deposited in St. Xavier's College Herbarium (XCH), Palayamkottai. The present finding extends the known distribution of these species. For easy identity, short descriptions including phenology, ecology and distribution are given.

***Memecylon flavescens* Gamble** Kew Bull. 1919:226. 1919 & Fl. Pres. Madras 1:503. 1997 (rep. edi.); K. Vivekananthan in Nair & Henry, Fl. Tamil Nadu 1:160. 1983; Ahmedullah & Nair, End. Pl. Indian Region 1:109. 1986; Sivarajan & Mathew, Fl. Nilambur 3:270. 1996.

Shrub to 1 m; branchlets sub-terete, glabrous, woody. Leaves decussate-opposite, elliptic-ovate, 2-5 x 1.5-2.5 cm, membranous, glossy, yellowish-green when dry, base cuneate, margin entire, recurved, apex obtuse-acute with

retuse. Flowers sessile, 4-7 mm, in axillary-lateral tubercled racemes; bracteoles oblong, to 1.5 mm; Calyx-lobes 4, ovate, to 1 mm, acute apex. Petals 4, blue, orbicular-ovate, 2 x 2 mm. Stamens 8, equal, to 3 mm. Ovary globose, 1 mm, 1-celled, papilose; ovules 6-10, central placentae. Berry globose, 7 x 6 mm, dark purple.

Fl. & Fr.: March-August.

Ecology: Rare in Evergreen Forests and Sholas between 700-1,500 m.

Distribution: INDIA: Tamil Nadu - Kanyakumari, Nilgiri. Kerala - Avalanche, Kundha.

Specimens Examined: Tamil Nadu - Kanyakumari district, Upper Kodayar 1,500 m, 7.viii.1996, Manickam, 10047 XCH; 1,500 m, 17.iv.1996, Manickam & Murugan 12630 XCH; Mahendragiri ?±700, 27.iii.1999, Murugan *et al.*, 18664 XCH; Nilgiri district, Avalanche, 2,000 m, 28.iii.1972, K. Vivekananthan, 79350 MH.

Ilex denticulata Wall. ex Wight, Ill. 2:t.142. 1850; Hook. f. Fl. Brit. India 1:600. 1875; Gamble, Fl. Pres. Madras 1:200. 1997 (rep. ed.); Ramamurthy in Nair & Henry, Fl. Tamil Nadu 1:72. 1983.

Tree, to 4-6 m; branchlets pubescent, sub-terete, Leaves alternate, elliptic-oblong, 5-8 x 3-5 cm, membranous, glossy, glabrous, base acute, margin obscurely serrate, revolute, apex obtuse-acuminate; nerves 5-7 pairs, obscure, looped; Petiole 1 cm, pubescent. Female flowers pale yellow, 5-8 mm diametre in axillary-umbel to 2 cm; Pedicel slender, 1-1.5 cm, puberulous; Peduncle 0. Calyx-tube cupular under 0.5 mm; lobes 4, ±0.25 mm. Petals 4, oblong 3 x 2 mm, pale yellow. Staminodes 4, equal, to 2 mm, alternate to Petals. Ovary globose, 1.5 mm, 4-celled; Ovules 1 in each locule, apical placentae. Stigma sessile, 4-lobed, thick.

Fl.: March

Ecology: Rare in Evergreen Forests at ±1,500 m.

Distribution: India (Tamil Nadu - Coimbatore, Madurai, Nilgiri, Salem and Kanyakumari districts) and Sri Lanka.

Specimens Examined: Tamil Nadu - Kanyakumari district, upper Kodayar, 1,000-1,500 m, 10.iii.1998, Manickam & Murugan, 14863 XCH; ±1,275 m, 27.iii.1984, Gopalan, 144877 MH; Nilgiri district, Longwood R.E., 2,075 m, 12.xi.1990, Vajravelu, 71384 MH.

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35. OCCURRENCE OF *BUTEA MONOSPERMA* VAR. *LUTEA* (WITT.) MAHESHWARI IN RAJASTHAN

During my posting in the forest areas of southern Aravallis in Udaipur district, I came across many trees of the yellow flowered *Butea monosperma* var. *lutea* which is still not included in any of the floras of Rajasthan State (Bhandari 1990; Sharma and Tiagi 1979; Shetty and Pandey 1983; Shetty and Singh 1987, 1991, 1993; Singh 1983).

The red flowered species of *Butea monosperma* is very common in Udaipur district and is mostly confined to the foothill forests; the yellow variety is rare, but can be seen in the same habitat. *B. monosperma* var. *lutea* closely resembles *B. monosperma*, except that it has yellow flowers. Occurrence of the yellow flowered *Butea* in Rajasthan is worth recording.

The Bhils and other tribals of Udaipur district consider the yellow flowered *Butea* trees sacred and never cut them.

Table 1: Location of *B. monosperma* var. *lutea* in Udaipur dist.

S. No.	Tehsil (Taluka)	Location	No. of trees	Status of land
1	Girwa	Alsigarh to Pai village road	1	Revenue
2.	Girwa	Near Pipalwas village, crop field to east of road	2	Revenue
3.	Jhadol	Near Pargiapada village (on Paliakhera-Madri road)	1	Revenue
4.	Jhadol	Mohammad-Falasia village	2	Revenue
5.	Kotra	Near Patharpadi Chowki of Phulwari Wildlife Sanctuary	1	Revenue
6.	Kotra	Umari Forest Block of Phulwari WLS near Bordi village	4	Reserve Forest

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36. NOTES ON THE DISTRIBUTION OF *BAUHINIA WALLICHII* MACBR. AND *B. OVATIFOLIA* T. CHEN, LEGUMINOSAE: CAESALPINIOIDEAE

Nayar (1996: 160, 180) included *Bauhinia wallichii* Macbr. and *B. ovatifolia* T. Chen in the list of endemic plants of "North Eastern India" and "Arunachal Pradesh Himalaya" respectively. The distribution of *B. wallichii* was given as "Arunachal Pradesh, Assam, Meghalaya, West Bengal and adjacent Bangladesh." The same distribution for *B. wallichii* was also given by Sanjappa (1992: 7), but they probably overlooked the publication of Larsen and Larsen (1980: 195) where it was stated that the species is distributed from India

(Silhet, Assam) to Myanmar and northern Vietnam. Recently, it has also been reported from southeastern Yunnan in China (Zhang and Chen 1996) and from northern Thailand (Larsen 1999). Therefore, considering the actual area of distribution, *B. wallichii* should not be referred to as an endemic species.

As regards *B. ovatifolia*, Nayar (1996: 180) gave the distribution as "Arunachal Pradesh and adjacent Tibetan hills." Sanjappa (1992: 4) and Chowdhery *et al.* (1996: 392) have also reported this species from Arunachal Pradesh. In the course of my study on the Bauhinias, I have, however, found that only one collection (*J. Joseph* 48504 – CAL) from the forest around Tihun in Lohit district, Arunachal Pradesh comes very close to *B. ovatifolia*, but its identity has yet to be confirmed (see Bandyopadhyay *et al.* 1993). I do not know the source from which the distribution of *B. ovatifolia* in Arunachal Pradesh has been taken by the aforesaid authors, but if it is based on *J. Joseph* 48504 (CAL) then it would be appropriate to treat *B. ovatifolia* as endemic only to the type locality (Tianyang, Guangxi) till its occurrence in Arunachal Pradesh is confirmed.

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37. PITS WITH INFLATED TRICHOMES ON UNDER SURFACE OF LEAVES OF *BAUHINIA MALABARICA* ROXB., LEGUMINOSAE: CAESALPINIOIDEAE

(*With one plate*)

Bauhinia subgen. *Piliostigma* sect. *Piliostigma* is represented in India by two species, namely *Bauhinia foveolata* Dalz. and *B. malabarica* Roxb.

Dalzell (in *J. Linn. Soc.* 13: 188. 1872) while describing *B. foveolata* mentioned, "The structure of the under surface of the leaf is very curious. There are numerous pits within the small areolae of the reticulations; and each is tenanted by one minute seed-like body attached to the cavity by a fine thread."

The aforesaid seed-like body is actually an inflated trichome that was also known by various other terms in the past (see Tucker *et al.* in *Bot. J. Linn. Soc.* 88: 291-301. 1984).

In the course of my study, I have observed that a few to many fine pits (some of them not so prominent as in *B. foveolata*) with an inflated trichome in each of them are present within the areolae of the reticulations on the under surface

Bandyopadhyay, S.: *Bauhinia foveolata* Dalz. PLATE 1

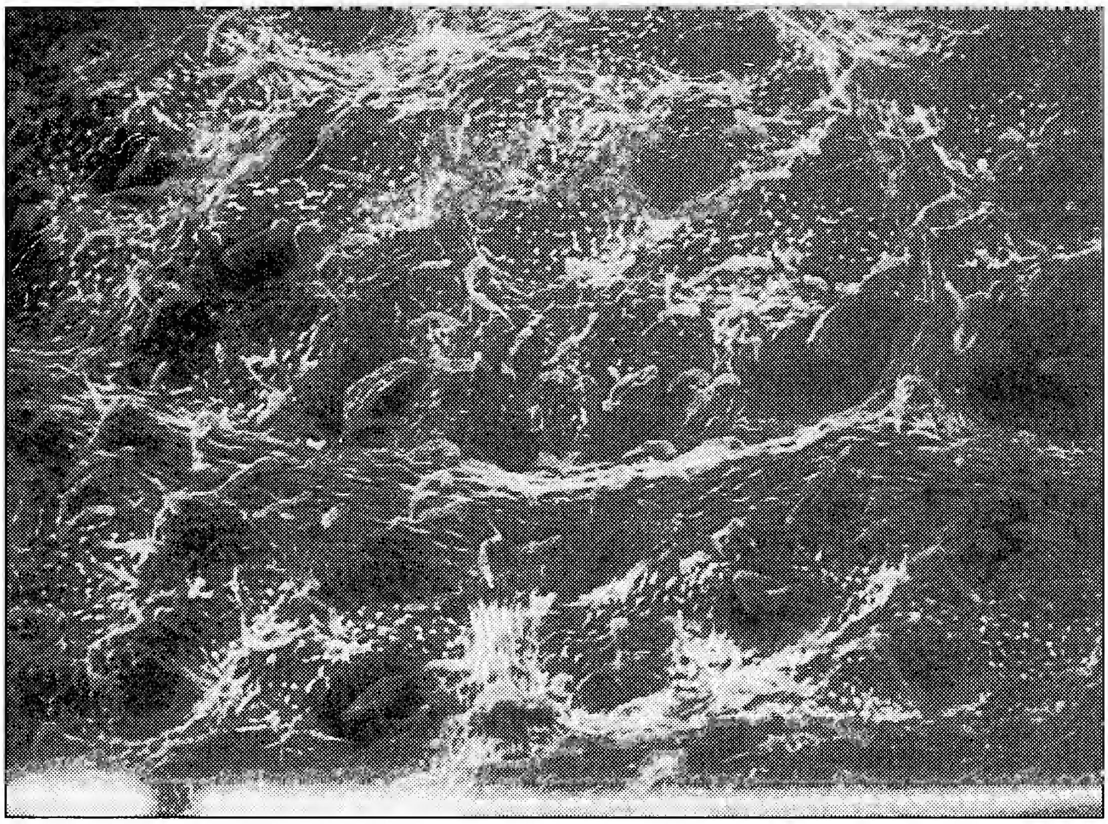

Fig. 1: *Bauhinia foveolata* Dalz; Scanning electron micrograph of pits with inflated trichomes on the under surface of a leaf. Source: K.V. Billore 116174 (CAL). Marker segments = 10 µm.

of the leaves of *B. malabarica* too, which have not been reported earlier. They were present in most but not all the specimens studied in CAL. Further, the pits are not so closely situated as in *B. foveolata* leaves except sometimes near the leaf margins. The inflated trichomes in the fresh leaves are at first hyaline, later yellowish to rusty. Finally they shrink and wither away after maturity of the leaves.

Many pits with inflated trichomes were also present on the under surface of the seed leaf of *B. malabarica*, observed on seedlings that grew under the trees of *B. malabarica* cultivated in Division 21 of the Indian Botanic Garden, Howrah. Das (1996) also studied the seedlings of the same tree by germinating some seeds received from me (Das, pers. comm.). However, he did not mention pits with inflated trichomes on the under surface of the leaves.

The voucher specimen (15.v.2000, *Bandyopadhyay* 105) of the seedlings of *B. malabarica* has been deposited in CAL.

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38. SEEDLING MORPHOLOGY OF *BAUHINIA FOVEOLATA* DALZ., LEGUMINOSAE: CAESALPINIOIDEAE

(*With one text-figure*)

Bauhinia L. subgen. *Piliostigma* (Hochst.) Kurz sect. *Piliostigma* is represented in India by two species, namely *Bauhinia foveolata* Dalz. and *B. malabarica* Roxb. Studies on the seedling morphology of the latter species were carried out by Troup (1921), Das (1996), and Das and Paria (1999). The latter, however, overlooked the publication of Troup (1921) where the seedling morphology of three more species, namely *B. racemosa* Lam., *B. purpurea* L. and *B. variegata* L. were described in detail. I describe here the seedling morphology of *B. foveolata*, which is endemic to India and found in semi-evergreen forests from 450-1,000 m in Gujarat, Dadra & Nagar Haveli, Maharashtra and Karnataka.

Eleven seed samples were scarified with a razor and sown in the soil at a depth of about 5 mm in September 1999. Six of the seeds germinated and the seedlings started protruding above the soil surface after three days. The average maximum and minimum temperature during that period were 32.5 °C and 26.5 °C respectively. The seedlings took another 65-73 days to reach the 4th leaf stage. One of the seedlings in the early 4th leaf stage has been deposited as a voucher specimen (13.xi.1999, *Bandyopadhyay s.n.*) in CAL.

Measurements of different parts of the seedlings, given here up to the 4th leaf stage, are those for the fully mature parts.

Duke and Polhill (1981) have been followed for terms like phaneroepigeal and foliar cotyledon.

Seedlings phaneroepigeal, 14-16.5 cm high at 4th leaf stage. Primary root 9-10 cm long, whitish-brown, terete, tapering; secondaries moderate in number, very fine, fibrous. Hypocotyl 1.2-1.7 cm long, whitish-green, arched at first,

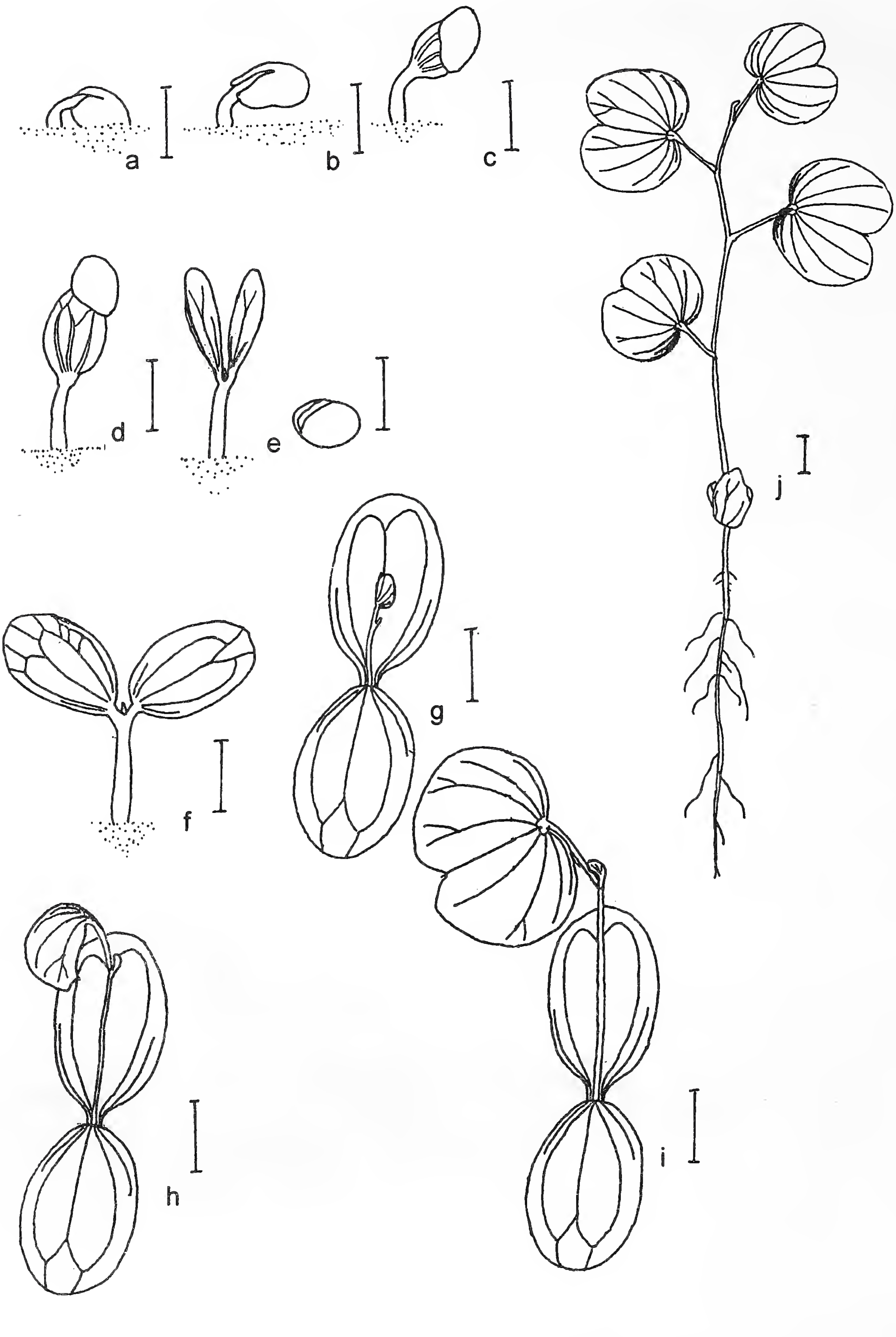

Fig. 1: *Bauhinia foveolata* Dalz.; a-j. Different stages of seedling up to the 4th leaf stage (Scale = 1 cm)

finally slightly curved or straight, stout, initially increases in diameter towards root, terete, becoming tetrangular and grooved near the foliar cotyledons, glabrous. Cotyledons 2 (exhibit up and down nyctinastic movement but do not fold like leaves – also see Pijl 1952: 295, 302), opposite, foliar, 2.3-2.9 x 1.6-2.0 cm, yellowish-green at first, finally green, wither through yellow to brown at 4th leaf stage, slightly fleshy, elliptic, sometimes slightly asymmetric, entire, obtuse at apex, more or less so at base, glabrous, 5-nerved (the young foliar cotyledons appear to be 3 or 4-nerved), middle one bifurcates near apex; petioles *c.* 2 mm long, green, flattened above, semi-lunar in T.S., with prominent pulvinus at distal end; interpetiolar region with hair-like outgrowths. Stem green, erect, slender, slightly angled, somewhat zigzag at nodes, at first pubescent, finally glabrescent. Leaves alternate, 2.0-3.2 x 3.0-4.0 cm, 1st leaf not much smaller than others, green, suborbicular to broadly ovate, 9 (1st leaf) -11 (2nd to 4th leaves)-nerved (nerves clearly visible to the naked eye except those near extreme leaf-base), bifid *c.* 1/5 their length into subacute to broadly obtuse lobes at apex, mucronate between lobes, shallowly cordate at base, upper surface glabrous, lower surface pubescent mainly along nerves and with fine pits within areolae of reticulations; pits not so closely situated as in mature leaves, each pit with a hyaline inflated trichome (see Tucker *et al.* 1984), which finally turns yellowish to rusty; petioles 1.3-2.4 cm long, green, herbaceous, dorsally grooved, with deep green pulvinus at both ends, pubescent, finally glabrescent. Stipules 2, minute, green, free, lateral, narrowly ovate, falcate, pubescent, deciduous.

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39. *SYZYGIUM NEESIANUM* ARN. (MYRTACEAE) — AN ADDITION TO THE INDIAN FLORA

(*With one text-figure*)

During a visit to Kodayar hills, Kanyakumari district, Tamil Nadu, an interesting specimen of a tree species of *Syzygium* Gaertner (Family Myrtaceae) was collected. The characters

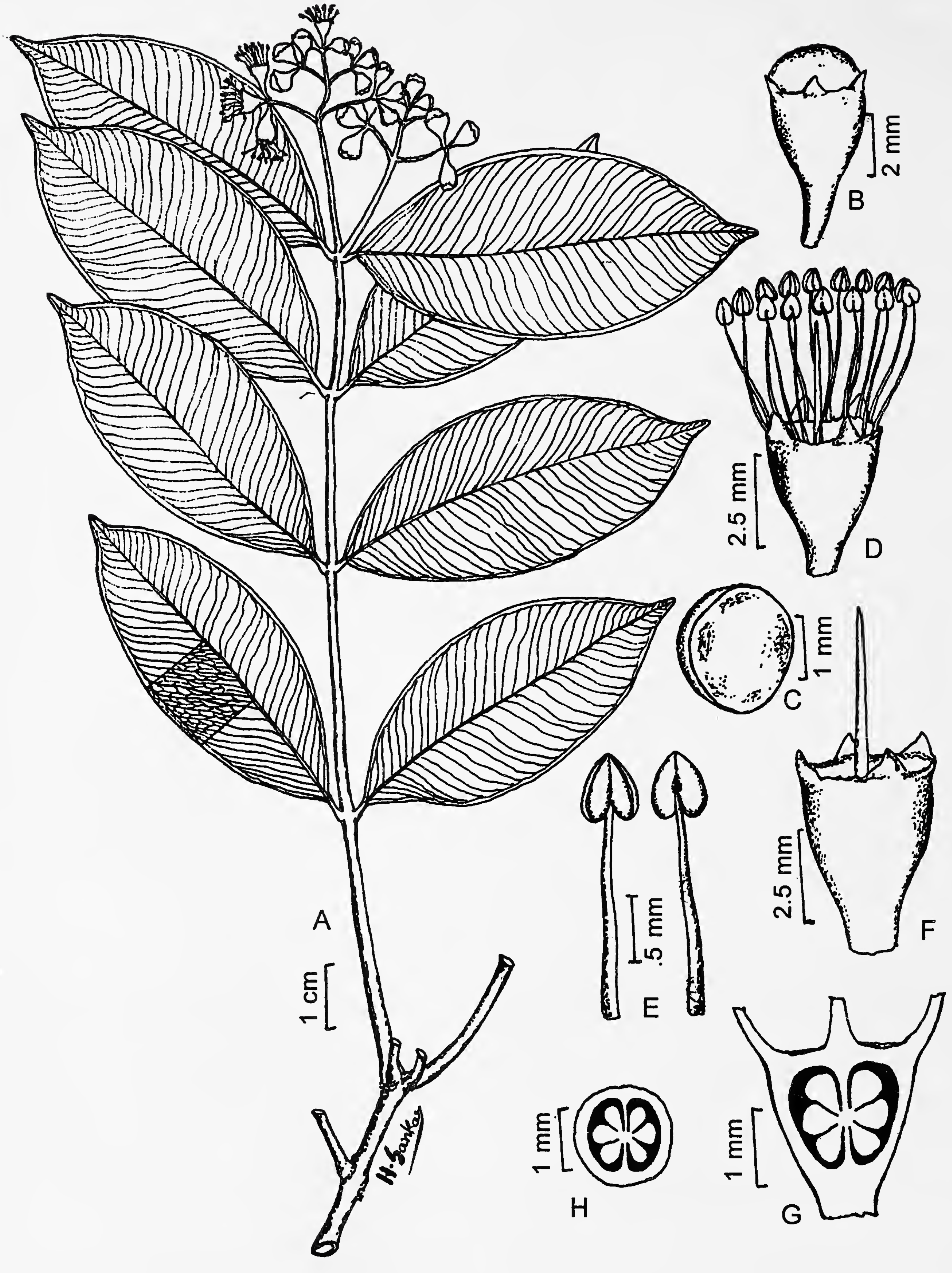

Fig. 1: *Syzygium neesianum* Arn.; A. Twig, B. Flower bud, C. Corolla, D. Flower without corolla, E. Stamen, F. Pistil with calyx, G-H. Ovary (L.S. & T.S.)

of this species do not agree with those of any known species of the genus from India. The tree was identified as *Syzygium neesianum* Arn., an endemic species of Sri Lanka (Ashton 1981). The present discovery is of great phytogeographical interest, and the specimens from Kodayar hills are identical to the Sri Lankan specimen housed in the Madras Herbarium (MH), Botanical Survey of India (Southern Circle), Coimbatore. A short description with illustration is provided to facilitate identification.

Syzygium neesianum Arn., L. Nova. Acta. Phys: Med. Acad. Caes. Teop. Carol. Nat. Cur. 18: 335. 1836; Thw., Enum Pl. Zeyl. 117: 1843; Alston in Trimen, Handb. Fl. Ceylon 6: 116. 1931; Ashton in Dassanayake & Fosberg, Rev. Handb. Fl. Ceylon 2: 442. 1981. *Eugenia neesiana* Wt., Ic. Pl. Ind. Or. t. 533. 1843; Duthie in Hook.f., Fl. Br. India 2: 493. 1879.

Small tree, to 6 m; branchlets terete, glabrous. Leaves opposite-decussate, oblong-lanceolate, 5-8 x 2-3.5 cm, coriaceous, glabrous, chocolate brown when dry, base subacute to subcordate, margin entire, slightly recurved, apex obtusely acuminate; lateral nerves many, sub-parallel; petiole 3 mm long, thick. Flowers 4 mm across, white, in terminal corymbose cymes, to 5 cm long; peduncle 3-10 mm long, terete; rachis 4-angled; pedicel up to 2 mm long; bract inconspicuous. Calyx-tube up to 3 mm long, glabrous; lobes 4, short, obscure. Petals 4, orbicular, up to 2 mm long, calyptrate, fugaceous. Stamens many, unequal, filaments filiform, 2-4 mm, cream; anthers ovate, *c.* 0.5 mm. Ovary inferior, globose, to 2 mm long, 2-loculed; 3-6 ovules in each, with central axile placentae; style filiform, subulate, to 4 mm long; stigma simple, acute at apex.

Specimens examined: INDIA: Tamil Nadu, Kanyakumari district: Kodayar (upper) Manickam & Murugan XCH 12454; Kerala — Idukki district: Meenmutti, Mohanan, MH acc. No. 151501; Quilon district, Naduvanoor — Kadavu path, Mohanan MH Acc. No. 113376; Quilon district: way to Thenmalai, Mohanan MH Acc. No. 117379; Trivandrum district: Bonnacard, Mohanan MH Acc. no. 117381. SRI LANKA: MH 60885 (s.no. L.P. 735).

Note: The specimens collected from Kerala and kept in MH, are misidentified as *Syzygium caryophyllatum* (L.) Alston, but they belong to *S. neesianum* Arn. due to the presence of leaves with sub-cordate base and, acuminate apex and calyx with 4 lobes.

ACKNOWLEDGEMENTS

We are grateful to the UGC for financial assistance. We thank Dr. R. Gopalan and Dr. V. Chelladurai for their suggestions and critical evaluation of the manuscript. We are grateful to the Field Director, Kalakad-Mundanthurai Tiger Reserve, India for permission to undertake the field studies.

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40. SOME NEW RECORDS OF ASTERACEAE FOR THE STATE OF MAHARASHTRA

While carrying out intensive plant explorations in southwestern Maharashtra, three members of Family Asteraceae were collected, which on critical study were identified as *Cyathocline manilaliana* Raju and Raju, *Laggera alata* (D. Don) Sch.-Bip. Ex. Oliver and *Wedelia glauca* (Ort.) S.F. Blake. Genus *Cyathocline* Cass. and genus *Laggera* Sch.-Bip. ex Koch. are represented by three species each and genus *Wedelia* Jacq. is represented by five species in

India (Rao *et al.* 1988; Hajra *et al.* 1995a, b; Prabhakar Raju *et al.* 1999).

Wedelia glauca (Ort.) S.F. Blake, a member of Compositae-Heliantheae is a native of Central Argentina, Uruguay and extreme south of Brazil. It is a well-known indigenous "weed" in Central Argentina and declared as an agricultural pest. It is toxic to livestock when in fruiting stage (Burkat and Carera 1953). It is poisonous for grazing cattle; in cows it causes abortion of the foetus in a few hours after consumption. The symptoms are somewhat like hydrocyanic acid poisoning (Bhattacharya *et al.* 1995).

The voucher specimens are deposited in the Herbarium of the Shivaji University, Kolhapur (SUK).

Cyathocline manilaliana Prabhakar Raju, C. and R.R. Venkata Raju in Rheedea 9(2): 151-154. 1999.

Erect, aromatic herb; stems often dichotomously branched from the base, glandular, pubescent. Leaves simple, radical and cauline, cauline leaves alternate, sessile, uninerved from base, nerves prominent below; puberulous and glandular on both surfaces, coriaceous; uppermost ovate; lower spathulate or oblong, lyrately lobed. Heads few, in terminal, compound corymbs, heterogamous, not rayed. Involucral bracts two seriate, shorter than florets, often recurved, glandular hairy. Receptacles cup-like, glabrous. Female florets numerous, tubular, filiform, pink, densely glandular-pubescent, 3-lobed, pappus absent. Bisexual florets few, pink-purple, thinly glandular-pubescent, 5-lobed. Stamens 5; anthers sagittately auricled at the base, pappus absent.

Fl. & Fr.: December-April.

Specimen examined: Salunkhe 1320.

Locality: Yeralwadi in Satara district, Maharashtra, India.

Note: Earlier it was known only from the type locality: Pochera fields, Adilabad district, Andhra Pradesh State. The present report extends its distribution to Maharashtra.

Taxonomic note: The original author of the species referred his specimens to S.R. Yadav (one of the authors), who confirmed that it was an undescribed species. It differs from *Cyathocline lutea* Law ex Wight (yellow flowers) in its pink-purple flowers and *C. purpurea* (Buch.-Ham. ex D. Don) O. Kuntze in possessing white-woolly globose vegetative propagules on stem bases, radical and cauline leaves and deeply sagittate anther base with sharp auricles.

Laggera alata (D. Don.) Sch.-Bip. Ex. Oliver in Trans. Linn. Soc. 29: 94: 1873; Pant in Hajra *et al.* (ed.) Fl. India 13: 148. 1995; Cooke, Fl. Pres. Bombay 2: 80. 1958 (Repr. Ed.) *Erigeron alatum* D. Don. Prodr. Fl. Nepal. 171.1825. *Blumea alata* (D. Don) DC. Prodr. 5: 448. 1836; Hook.f. Fl. Brit. India 3: 271.1881.

Erect, branched, stout herb, stem winged; stems and branches clothed with glandular pubescence. Leaves sessile, decurrent on stem forming entire wing, 2.5-10 x 1-3 cm, oblong, obtuse or subacute, serrate-dentate or rarely entire, pubescent on both surfaces. Heads few, in leafy racemes, 1-1.5 cm in diameter; peduncles axillary, solitary, often drooping; bracteate. Involucre campanulate; bracts many seriate, the outer lanceolate, acute, much shorter than inner, pubescent outside, the innermost scarious, subglabrous, linear, acuminate. Corolla of bisexual florets purplish. Achenes dark brown, puberulous, faintly ribbed, appressedly hairy, villous; pappus white.

Fl. & Fr.: December-May.

Specimen examined: Sardesai 1907.

Distribution: Here and Panhala in Kolhapur district.

Note: Earlier it was known from Assam, Bihar, Himachal Pradesh, Karnataka, Madhya Pradesh, Manipur, Orissa, Sikkim, Tamil Nadu and Uttar Pradesh.

Wedelia glauca (Ort.) S.F. Blake. in Contrib. Gray Herb. n. ser. 3(52): 39. 1917. *Pascalia glauca* Orteg. Hort. Matr. Dec. 39. t.

4. 1797; Bhattacharya *et al., J. Bombay nat. Hist. Soc. 92*: 136-137. 1995.

Perennial herb. Stem with longitudinal striations, scabrous. Leaves simple, opposite, distichous, base narrow, apex acuminate, generally 1-2 dentate in lower part of lamina. Heads solitary in the leaf axils, 1-1.5 cm in diameter, heterogamous, radiate. Disc florets hermaphrodite, fertile, involucre hemispherical; peduncles hairy; bracts 2-seriate; outer linear, shortly acuminate, acute or rounded at apex, inner lanceolate, acuminate. Palea membranous, folded, oblong-lanceolate, acute. Florets bisexual; corolla yellow; ligulate in female flowers, 5-fid at apex. Style branched in the appendix, hairy at the apex. Achenes obovoid, more or less compressed, cuneate, rugulose or glabrous, ray flattened above. Disc tetragonal, laterally compressed. Pappus minutely scaly, short.

Fl. & Fr.: December-April.

Specimen examined: Shimpale 101.

Distribution: Islampur in Sangli district.

Note: Earlier it was known only from Tiruppur, Coimbatore from the State of Tamil Nadu.

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41. EMENDING OF AN ENDEMIC AND CRITICALLY ENDANGERED SPECIES *CINNAMOMUM WALAIWARENSE* KOSTERM., FAMILY LAURACEAE, OF KALAKAD-MUNDANTHURAI TIGER RESERVE, INDIA

(*With one text-figure*)

Kostermans (1983) described a new species, *Cinnamomum walaiwarense* based on fruiting specimens (26252 & 26301, K, L) collected during July 1976 in the southern

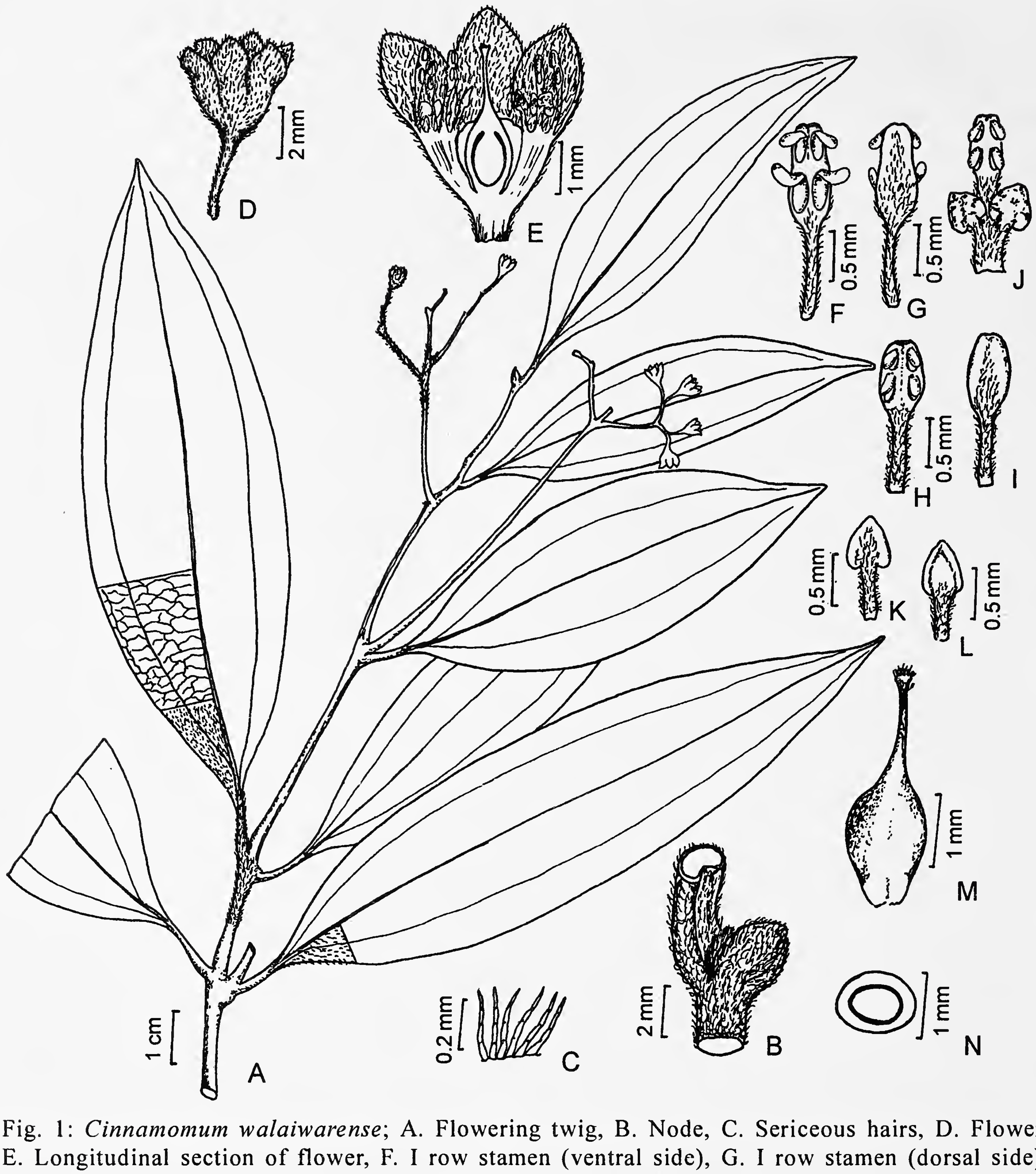

Fig. 1: *Cinnamomum walaiwarense*; A. Flowering twig, B. Node, C. Sericeous hairs, D. Flower, E. Longitudinal section of flower, F. I row stamen (ventral side), G. I row stamen (dorsal side), H. II row stamen (ventral side), I. II row stamen (dorsal side), J. III row stamen (ventral side), K. Staminode (dorsal side), L. Staminode (ventral side); M. Ovary; N. Cross section of ovary

tropical wet evergreen forest of Walaiwar Cardamom Estate at about *c.* 1,000 m above msl in West Tinnevelly, currently the Kalakad-Mundanthurai Tiger Reserve (KMTR) in India. Narrow distribution and sparse population within the KMTR make this species endemic and critically endangered. During the inventory in 1999, flowering specimens were collected. Based on the floral characters and an illustration, the earlier description is emended here.

Cinnamomum walaiwarense Kosterm. in Bull. Bot. Surv. India 25:119. 1983.

Tree, up to 15 m high and 115 cm dbh; bark very smooth, light brown, *c.* 0.6 mm thick; live bark *c.* 3 mm thick, light brown, slimy, without odour. Wood white, odourless. Branchlets: tender ones sericeous, quadrangular; mature ones subterete to terete, subglabrous to glabrous, densely and finely subsericeous at apical end; hairs 0.2-0.3 x *c.* 0.02 mm. Terminal buds small, with similar indumentum. Leaves opposite, chartaceous, oblong-lanceolate, 5-14.7 x 1.9-4 cm, acute or acuminate at base, entire at margin, obtusely acute, subacuminate or acuminate at apex; glabrous, smooth, glossy above; densely and finely sericeous below; midrib slender, prominent, impressed above; raised and canaliculate below, glabrous above, subsericeous below; subbasal lateral nerves till acumen base, prominent above, raised and canaliculate below; secondary nerves faint, parallel, horizontal, 2-4 mm apart; petioles 8-14 x 1-2 mm, sericeous, subterete, concave above, convex below. Panicles axillary, up to 8.5 cm long; tender ones quadrangular, sericeous; matured ones subterete or terete, glabrous; primary branchlets up to 6.5 x 0.12 cm; secondary branchlets up to 20 x 0.8 mm; tertiary branchlets up to 5 x 1 mm; pedicels up to 4 x 1 mm, quadrangular, sericeous; bracts deciduous. Flowers *c.* 4.4 x 4.4 mm. Tepals in 2 rows, 3 + 3, ova , sericeous, *c.* 3 x 2 mm. Stamens 9, in 3 rows, 3 in each row; I row antitepalous, introrse, eglandular, *c.* 2.6 x 0.6 mm; II row antitepalous, introrse, eglandular, *c.* 2.2 x 0.6 mm; III row antitepalous, extrorse, opposite to I row, glandular, *c.* 2.2 x 1 mm; glands 2 on each filament, cordate, glabrous, *c.* 0.45 x 0.45 mm; anthers 4-celled, elliptic, opening up by forward flaps. Staminodes 3, opposite to II row, sagittate, stipitate, densely sericeous to sparse above, *c.* 1.8 x 0.4 mm. Ovary superior, ellipsoid, 1-celled, glabrous, *c.* 1.7 x 1.1 mm; ovule solitary, pendulous; style glabrous, *c.* 1 x 0.2 mm; stigma subpeltate, *c.* 0.2 x 0.2 mm. Immature fruits ellipsoid, apiculate. Perianth tube cup-shaped, deep, rather fleshy, conspicuously and longitudinally ribbed, slightly more than half of basal part of tepals, indurate, persistent; cup base obconical, merging into obconical short pedicel, *c.* 5 x 4 mm.

Specimens examined: Tamil Nadu, Tirunelveli district, Kakachi, 7.iv.1999, *c.* 800 m, M.B. Viswanathan & U. Manikandan 3859.

Local name: Elavangam in Tamil.

Note: Kostermans (*l.c.*) distinguished this species from *Cinnamomum travancoricum* by the leaf shape and by its much shorter indumentum on the panicles. Longer and quadrangular pedicels, ovate tepals and sericeous hairy nature of the tepals and stamens further distinguish *C. walaiwarense.*

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42. A NOTE ON THE ADDITIONAL HOST RANGE FOR THE GENUS *KORTHASELLA* VAN TIEGH. FAMILY LORANTHACEAE, FROM NILGIRIS, SOUTHERN INDIA

During floristic studies in the Mukkurthi National Park in November 2000, we were able to collect a number of rare and endemic plants of the Nilgiris. In addition to the above, our research team also collected a curious semi-parasitic plant in the Mukkurthi Dam area, later identified as *Korthasella japonica* (Thunb.) Engler (Family Loranthaceae). While collecting the parasitic plant, the host plants were also noted and identified. The literature (J.S. Gamble and C.E.C. Fischer, Fl. Pres. Madras, 1957 [Repr. Ed.]) indicates that the genus *Korthasella* normally grows only on *Rhododendron arboreum* J.E. Smith subsp. *nilagirieum* (Zenk) Tagg. (Family Ericaceae), whereas our observations revealed that it can also grow on species like *Canthium neilgherrense* Wight var. *chartaceum* (Gamble) Swamin. (Family Rubiaceae), *Ilex wightiana* Wall. ex Wight (Family Aquifoliaceae) and *Ternstroemia japonica* (Thunb.) Thunb. (Family Theaceae). We conclude that the above mentioned species form additional hosts for *Korthasella* in the Nilgiri hills, and hope that further intensive explorations will throw more light on its host range.

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43. REDISCOVERY OF A CRITICALLY ENDANGERED SPECIES *PHYLLANTHUS BEDDOMEI* (GAMBLE) MOHANAN, EUPHORBIACEAE, FROM KALAKAD-MUNDANTHURAI TIGER RESERVE IN INDIA

(With one text-figure)

Gamble described a new species of *Reidia, R. beddomei* based on the collections of R.H. Beddome from Chokkampatti in Tirunelveli hills, and T.F. Bourdillon from Travancore hills, at about 1,640 m, in 1925. Mohanan in 1985 transferred this species to *Phyllanthus* and made a combination — *Phyllanthus beddomei.* Using this literature, specimens collected from the Kalakad-Mundanthurai Tiger Reserve (KMTR) of Tirunelveli District, Tamil Nadu, were identified. Dr. N.P. Balakrishnan, expert on Euphorbiaceae, confirmed the identity. This species was rediscovered after a lapse of about 73 years in 1998. There is no specimen in MH. Its populations are found only in one locality, the species deserves the critically endangered threat category. The species is described with related details and illustrated to help identification for facilitating conservation.

Phyllanthus beddomei (Gamble) Mohanan in J. Econ. Tax. Bot. 6: 480. 1985. *Reidia beddomei* Gamble in Kew Bull. 1925: 331. 1925 & Fl. Pres. Madras 1293. 1925 & 2: 904. 1957 (repr. ed.).

Subshrub, up to 2 m high, branches spirally arranged towards apex, glabrous. Leaves alternate, obliquely ovate, 2-3.7 x 0.7-1.2 cm, truncately obtuse at base, entire and thickened at margin, apiculate at apex, coriaceous, green above, pale green below, punctate, glabrous

Fig. 1A-M: *Phyllanthus beddomei*; A. Twig, B. Bract, C-G. Male flower: C. Flower, D. Outer tepal, E. Inner tepal, F. Gland, G. Anthers with staminal column; H-K. Female flower: H. Flower, I. Tepal, J. Ovary, K. Cross section of ovary; L. Capsule and M. Seed

above, glaucous below, obscurely 10-14 nerved; petioles brown, *c.* 2 x 0.5 mm; stipules brown, linear-deltoid, truncate at base, hyaline at margin, glandular at base inside, *c.* 4.5 x 1 mm. Flowers unisexual, axillary, in clusters, surrounded by numerous bracts; bracts linear-lanceolate, *c.* 3 x 0.6 mm, acuminate at apex, glabrous. Male: Pedicels filiform, *c.* 3.5 x 0.2 mm, glandular striate, glabrous.

Tepals 4, broadly ovate, unequal, whitish-yellow, tinged pinkish-brown, obtusely rounded at base, entire at margin, mucronate at apex,

striated; outer larger, *c.* 1.8 x 1.2 mm; inner smaller, *c.* 1.3 x 1 mm; striations glandular, visible outside, invisible inside. Disc glands 4, whitish-yellow, alternate with tepals, glabrous, *c.* 0.6 x 0.8 mm; midrib prominent; side nerves obscure. Stamens 4; filaments yellow, connate, *c.* 0.5 mm long; anthers 4, yellow, dehiscing transversely, *c.* 0.4 x 0.6 mm. Female: Pedicles glandular striate just above middle, broadened towards apex, *c.* 16 x 0.02-0.12 mm. Tepals 5 or 6, ovate, subequal, *c.* 3 x 1.3 mm, pinkish-brown, tinged whitish-yellow, connate at base, distantly crenate-dentate at margin, bluntly acute at apex, striated; striations glandular, visible outside, invisible inside; midrib prominent; side nerves obscure, 8-10. Disc glands combined as fleshy ring, *c.* 0.2 x 2.2 mm. Ovary yellow, globose, 3-valved, glabrous, *c.* 0.6 mm across; styles 3, each bifid from base, glabrous, *c.* 0.8 x 0.1 mm. Capsules subglobose, smooth, 3-lobed, 2-seeded in each lobe, glabrous. Seeds 6, trigonous, brown, minutely pubescent, *c.* 4 x 2.1 mm.

Specimens examined: Tamil Nadu: Kalakad-Mundanthurai Tiger Reserve, 8° 20'-8° 53' N and 77° 10'-77° 35' E, Aruvatheeti, *c.* 490 m, 19.viii.1998, M.B. Viswanathan, N. Ramesh, M. Maridass & U. Manikandan 1149.

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44. REDISCOVERY OF *PHYLLANTHUS ROTUNDIFOLIUS* KLEIN EX WILLD., EUPHORBIACEAE, AFTER 101 YEARS (1899-2000) IN KANCHIPURAM DISTRICT, TAMIL NADU, SOUTH INDIA

(*With one text-figure*)

The Flora of Tamil Nadu (II: 238.1987) records the distribution of *Phyllanthus rotundifolius* Klein ex Willd. in Chengalpattu, Ramanathapuram, Thanjavur and Tirunelveli districts. The Madras Herbarium, Coimbatore, holds 5 sheets from Chengalpattu; 4 from Ramanathapuram; 5 from Thanjavur; 4 from Tirunelveli district and 1 from Puthukottai district. The Chengalpattu district (now Kanchipuram district) collections were from Elliots' Beach - Madras and Sadras Beach during 1883, 1899 and 1900. All determined by J.S. Gamble in 1915.

This is a rediscovery after 101 years (1899-2000) from Kanchipuram district, Tamil Nadu (RHT 61774 from Mamallapuram Sand dunes - 6.i.2000). I got only 3 plants of this threatened species in an overgrazed area. Mayuranathan, P.V. reported this (Flowering Plants of Madras, p. 264) in 1929 and later workers could not locate

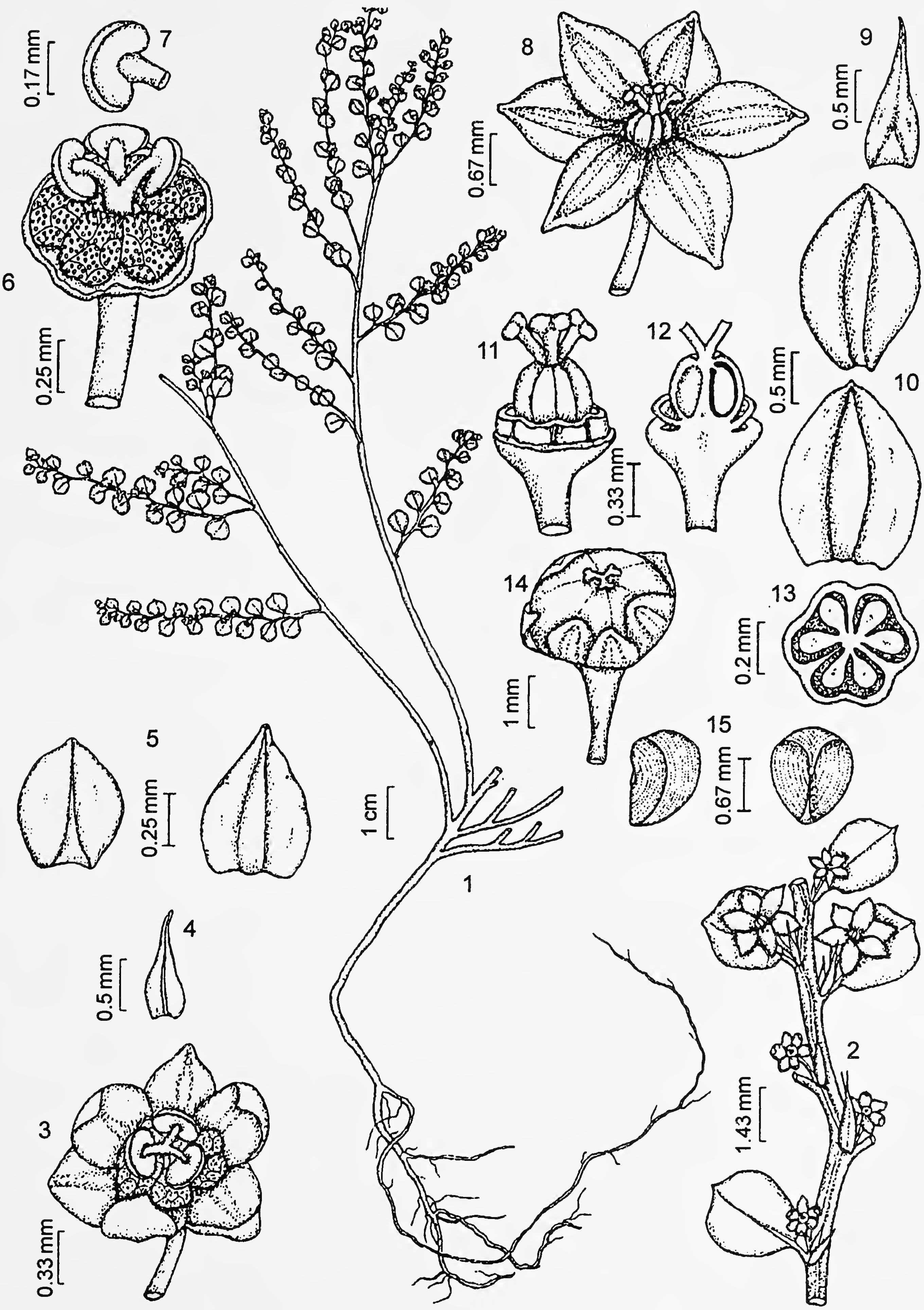

Fig. 1: *Phyllanthus rotundifolius* Klein ex Willd; 1. Habit, 2. Inflorescence, part ♂, 3. Flower, 4. Bract, 5. Perianth-lobes, 6. Staminal column with disk, 7. Stamen ♀, 8. Flower, 9. Bract, 10. Perianth-lobes, 11, 12 & 13. pistil: entire, l.s. & t.s., 14. Fruit, 15. Seed (RHT 61774)

this plant during the revision work (p. 248) in 1994.

Phyllanthus rotundifolius Klein ex Willd. Sp. Pl. 4: 584.1805; Hook.f. Fl. Brit. India. 5: 299.1887; Gamble, Fl. Madras 2: 903. 1957 (repr. ed.); Henry, A.N. Fl. TN. II: 238. 1987.

Prostrate herbs with long, woody, thick tap-root; stems round or compressed, glabrous; stipules linear, white, *c.* 1.5 x 0.4 mm. Leaves simple, alternate, fleshy, sub-orbicular to obovate-spathulate, 2 x 2 - 4 x 4 mm, glabrous above, glaucous below, base rounded-cuneate, margin entire, apex obtuse or rounded, apiculate; petiole to 1 mm, pale yellow. Male flowers: 2-3 per axil, usually together with one female flower; male flowers: pedicels 0.5 mm long; tepals 6, elliptic, 0.3 x 0.2-0.7 x 0.5 mm, pale yellowish-green midrib; stamens 3, small, filaments connate in the lower half; anthers to 0.3 mm across. Female flower: pedicel to 0.8 mm long; tepals 6, the outer ovate, 1.5 x 1.2 mm, the 3 inner obovate, 1.8 x 1 mm, obtuse, white with a broad median green band; ovary sessile, subglobose, 0.5 x 0.7 mm, smooth; styles free, to 0.4 mm, at first suberect, later divaricate to spreading, bifid stigmas, slightly swollen at apex. Capsules depressed-subglobose, 1 x 2 mm, smooth, yellowish-brown; fruiting pedicels up to 2.5 mm; persistent outer tepals *c.* 2.5 x 1.4 mm, inner tepals *c.* 2.5 x 1.5 mm; seeds 6, light brown, *c.* 1 x 0.5 mm, sharply triquetrous with 6-7 longitudinal ridges on the dorsal facet, and 5-6 concentric ridges on each ventral facet, with numerous transverse striae between the ridges.

Fl. & Fr.: January.

Distribution: Very rare; seen only in Mamallapuram sand dunes close to beach area, Kanchipuram district RHT 61774 dt. 6.i.2000.

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45. ADDITIONS TO THE ORCHID FLORA OF MAHARASHTRA

Orchidaceae is one of the largest and economically important families. More than 25,000 species of more than 600 genera are recorded under the family. About 130 genera and 900 species have been recorded from India by J.D. Hooker (1872-1897). For Bombay State, Cooke (1901-1908) reported 31 genera, 85 species and two varieties. Santapau and Kapadia (1966) extended the list of orchids to 116 species and three varieties belonging to 37 genera. Sharma *et al.* (1996) recorded 34 genera, 109 species and three varieties for the State of Maharashtra.

During our field studies in southwestern Maharashtra, we came across four rare and interesting orchids: three terrestrial and one epiphytic. On critical examination, they were identified as *Epipogium roseum* (D. Don) Lindl. *Gastrochilus flabelliformis* (Blatt. & McC.) Saldh., *Pachystoma senile* (Lindl.) Reichb. f. and *Zeuxine gracilis* (Breda) Bl. The genera *Epipogium* and *Pachystoma* are reported for the first time from Maharashtra. Genus *Epipogium* is represented by 3 species, *Gastrochilus* by 12 species, *Zeuxine* by 15 species and *Pachystoma* by a single species in India (Karthikeyan 1989).

The voucher specimens are deposited in the Herbarium of the Shivaji University, Kolhapur (SUK).

Epipogium roseum (D. Don) Lindl., in J. Linn. Soc. 1: 177. 1857; Sant. in Proc. Nat. in. Sci. India 24 B: 138; Sant. & Kapad. Orch.

Bombay 237. 1966. *Limodorum roseum* D. Don, Prodr. Fl. Nep. 30, Febr. 1825. *Galera rosea* Bl. Bijdr. 416, f. 3, Dec.-1825. *Epipogium nutans* Reichb. f., Bonpland. 5a: 36. 1836; Hook. f. Fl. Brit. India 6: 124. 1890.

Perennial herb; tuber ovoid, horizontal with few short internodes. Scapes leafless, 10-25 cm long, hollow, fleshy, greyish-yellow. Flowers drooping, pedicellate, bracteate; pedicels recurved. Bracts shorter than ovary. Sepals hyaline. Petals white, not very spreading, 3-nerved. Lip as long as or rarely longer than the sepals, concave, irregularly crenulate with the sides raised at the base; upper surface minutely warted in two rows; column white with reddish-brown spots. Spur short, bulbous, pointing backwards. Stigmatic surfaces at the base of column prominent. Ovary broadly ovoid, drooping, pale yellow.

Fl. & Fr.: April-June.

Exsiccata: Sardesai-2035.

Very rare, terrestrial saprophytic herb collected only once on the way to Vishalgad from Amba. Grows in deep shade and is very delicate.

Distribution: Gajapur in Kolhapur district.

Gastrochilus flabelliformis (Blatt. & McC.) Saldh., Fl. Hassan district (Mss.); *Saccolabium flabelliformis* Blatt. & McCann, Rev. Fl. Pres. Bombay, 16: 722. 1932.

Small epiphytic herb. Leaves 2-5, narrowly oblong, falcate with purple tinge and dots, apex unequally 2-lobed. Flowers many in corymbose racemes. Flowers bracteate; bracts persistent. Sepals obovate-oblong, spreading, fleshy, yellow with red blotches near tip. Petals obovate-oblong, spreading, fleshy, yellow with red blotches near tip, slightly shorter and narrower than sepals. Lip minutely lobed with cup-shaped hypochile; epichile slightly deflexed and minutely fimbriate on the outer edges. Column short, footless, wings purple. Pollinia two, globose with slender caudicles.

Fl. & Fr.: March-July.

Specimen Examined: Sardesai-2502.

Distribution: Dodamarg in Sindhudurg and Vasota in Satara district.

Pachystoma senile (Lindl.) Reichb. f. Bonplandia 3: 250. 1958; Hook. f. Fl. Brit. India 5: 812, 1888; Sant. & Kapad., Orchid Bombay 191, 1966. *Apathuria senilis* Lindl., Gen. Sp. Orchid. 130. 1831.

Terrestrial rhizomatous herb. Leaves 1-2, narrowly oblong-lanceolate or acicular, subplicate. Scape 20-30 cm long, erect, sheathed in basal region, glabrous. Flowers 5-6, secund, bracteate, pedicellate in lax racemes, never opening widely, glandular-pubescent. Bracts hyaline, membranous, many nerved, glabrous. Pedicels erect at anthesis, recurved in fruiting. Sepals entire, 5-nerved, shortly pubescent, wider than petals. Petals narrowly spathulate, 3-nerved, pinkish. Lip 3-lobed, clawed at base, sparsely pubescent, mid-lobe larger than side lobes and purple. Disc with 5 prominent longitudinal, parallel ridges. Column arched, glandular pubescent at the base. Pollinia 8.

Fl.: February-March.

Specimen examined: Bachulkar-323.

Distribution: Koyana Nagar in Satara district, Maharashtra.

Zeuxine gracilis (Breda) Bl. Fl. Jav. n.s. 56. t. 18. f. 2. t. 23D. 1858; Sant. & Kapad. Orch. Bombay 171. 1966. *Psychechilos gracile* Breda, Gen. Sp. Orchid Trim. t. 9. 1827. *Monochilus affine* Lindl., Gen. Sp. Orchid. 487. 1840. *Zeuxine affinis* Benth. ex Hook.f. Fl. Brit. India 6: 108. 1890. *Z. blatteri* Fisch. in Gamble Fl. Madras Pres. 1456. 1928.

Delicate herbs, 10-25 cm tall. Rhizomes creeping, sheathed at nodes; fleshy, dark green. Leaves 2-6, olive-green or greyish-green, sheathing at base, subsessile. Spikes glandular, pubescent mixed with long hairs, with 2-3 sheathing bracts. Flowers 3-7 in spikes. Sepals subequal, entire, 1-nerved, glandular-pubescent. Petals entire, 1-nerved, gland dotted, pale-pinkish or pinkish-white. Lip fleshy, strongly saccate at the base, with 2 curved papillae within

the sac. Anther ovoid, pale pink. Capsules ellipsoid, glabrescent.

Fl. & Fr.: February-April.

Specimen examined: Sardesai-2045.

Rare undergrowth in deep shade and moist places.

Distribution: Chandgad, Dajipur, Here and Patgaon in Kolhapur district.

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46. ADDITIONS TO THE FLORA OF KARNATAKA

While investigating the flora of Dakshina Kannada and Udupi (erstwhile South Kanara) districts of Karnataka, I came across four species of plants not previously recorded from Karnataka. The following list gives their correct nomenclature, distribution and, flowering and fruiting seasons. The species have been arranged alphabetically. All specimens are deposited at the Botanical Survey of India and in the Herbarium of the Poornaprajna College, Udupi.

1. ***Desmodium scorpiurus*** (Swartz) Desvaux, Journ. de Bot. Ser. 2, 1: 122. 1813; Dhruvan Tandyekkal & Philip Mathew, Rheedea 5(2): 177-179, Fig. 1. 1995. *Hedysarum scorpiurus* Swartz, Prodr. Veg. Ind. Occ. 107. 1788 (FABACEAE).

A native of tropical America. In India, it has been reported only from Kerala. This plant appears to be a recent introduction to coastal Karnataka.

Fl. and Fr.: December-May.

Exsiccata: Udupi district: Udupi, growing along roadsides, October 23, 1999, *K.G. Bhat* 11334.

2. ***Quisqualis malabarica*** Bedd., Icon. Pl. Ind. Or. 1: 33, t. 155. 1874; Clarke in Hook.f., Fl. Brit. Ind. 2: 460. 1878; Gamble, Fl. Pres. Madras 469. 1919; Gangopadhyay and Chakrabarthy, J. Econ. Tax. Bot. 21(2): 332, Fig. 15. 1997 (COMBRETACEAE).

This endemic species is so far known only from Kerala and Tamil Nadu. The recent collection of this species from Dakshina Kannada is a new record of its extended distribution in S. India.

Gangopadhyay and Chakrabarthy (*l.c.*) in their key for the species of *Quisqualis,*

distinguish *Q. malabarica* from *Q. indica* L. by tetramerous flowers. But in my specimens, the flowers are consistently pentamerous. Moreover, there is no reference to tetramerous flowers in *Q. malabarica* in the floras cited above.

Fl. and Fr.: January-March.

Exsiccata: Dakshina Kannada district: Panaje, growing near an arecanut garden, January 29, 2000, *K.G. Bhat* 11346.

3. ***Scaevola plumieri*** (L.) Vahl, Symb. Bot. 2: 36. 1791; Gamble, Fl. Pres. Madras 734. 1921. *S. lobelia* Murr., Syst. Veg. ed. 13, 1774, *nom. illeg.*; Clarke in Hook.f., Fl. Brit. Ind. 3: 421. 1881; Cooke, Fl. Pres. Bomb. 2: 70. 1904. *Lobelia plumieri* L. Sp. Pl. 929. 1753, *p.p.* (GOODENIACEAE).

A rare sand-dune plant, collected near the sea from Padubidri. It closely resembles *S. sericea* Vahl, but the leaves are smaller and the drupe is purple.

Fl. and Fr.: June-December.

Exsiccata: Udupi district: Padubidri, growing near the sea on sand, August 10, 1999, *K.G. Bhat* 11311.

4. ***Spermacoce assurgens*** Ruiz & Pavon, Fl. Peru 1: 60, t. 92. 1798; Sivarajan *et al.*, Proc. Indian Acad. Sci. (Plant Sci.) 97(4); 351, fig. 44-50. 1987. *S. laevis* sensu auct. mult.: Verdc., Fl. Trop. E. Africa Rubiac. 1: 357. 1976; Deb & Dutta, J. Econ. Tax. Bot. 5: 1051. 1984, non Lam. 1792. *Borreria laevis* auct. mult.: Bremekamp in Pulle, Fl. Suriname 4: 289. 1934, non (Lam.) Griseb. 1861 (RUBIACEAE).

A native of tropical America. In India, so far, known only from Kerala and Nicobar Islands.

Fl. and Fr.: October-November.

Exsiccata: Dakshina Kannada district: Mangalore, growing along the roadside, October 25, 1999, *K.G. Bhat* 11335.

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47. SOME NEW RECORDS FOR THE STATE OF MAHARASHTRA

During extensive and intensive plant exploration in Maharashtra, 2 species of *Eriocaulon*, namely *Eriocaulon martianum* Wall. Ex Koern., and *E. palghatense* Ans. & Balak., and 2 species of *Utricularia*, namely *Utricularia malabarica* Janarthanam & Henry, and *U. minutissima* Vahl were collected, which form new records for the State.

The voucher specimens are deposited in the Herbarium of the Shivaji University, Kolhapur (SUK).

Eriocaulon martianum Wall. ex Koern., Linnaea 27: 642. 1856; Ans. and Balak. Fam. Eriocaul. India 107. 1944; Cook, Aquatic and Wetland Plants of India, 197. 1996. *E. quinquangulare* var. *martianum* (Wallich) Fyson, J. Ind. Bot. 1: 204. 1921.

Erect acaulescent herb. Leaves long, linear acuminate, glabrous. Peduncles glabrous. Head 3-4 mm across, globose-subglobose. Receptacle columnar villous. Involucral bracts erect, elliptic, acute, chartaceous, glabrous, straw coloured. Floral bracts, oblanceolate-cuneate, acuminate, chartaceous, hairy towards apex, grey. Male flowers: sepals 3, connate to form open spathe, obovate, 3-lobed, lobes acute, grey, glabrous. Petals 3, subequal, ovate, hairy, each with black gland. Anthers 6, globose, black. Female flowers: pedicles minute; sepals 3, free, elliptic, falcate, flat, acute, equal, glabrous or sparsely hairy. Petals 3, free, equal, spathulate, obtuse or acute, hyaline, sparsely hairy. Ovary stalked, obovoid-

globose; style 3-fid. Seeds oblong-obovoid, obtuse; cells of seed coat transversely elongated, aligned in vertical rows; appendages ribbon-like band or rectangular structures from transverse radial wall.

Fl. & Fr.: September-December.

Specimen Examined: Bhuskute 224.

Distribution: Hazara falls, Darekasa in Bhandara district.

Note: Earlier it was known from Madhya Pradesh and West Bengal.

Eriocaulon palghatense Ans. & Balak. Fam. Eriocaul. India 111, f. 37. 1994.

Erect, acaulescent herb. Leaves linear, acute or subacuminate, glabrous. Peduncles few to many, glabrous. Head 1.5-2 mm across, ovoid or globose, black. Receptacle globose or cylindrical, glabrous. Involucral bracts oblong-obovate, obtuse or rounded at apex, entirely black, glabrous, chartaceous. Floral bracts oblanceolate, acute or subacute, hairy towards apex, grey or black. Male flowers: pedicels minute. Sepals 3, united into spathe, 3-lobed, obovate; lobes obtuse, hairy towards apex, black. Petals 3, minute, glabrous, each with black gland. Anthers 6, black. Female flowers: sepals 3, equal, free, linear-lanceolate, acute or subobtuse, black, hairy at apex. Petals 3, free, linear-spathulate, obtuse or subacute, hyaline. Ovary ovoid-ellipsoid; style 3-fid; stigma filiform. Seeds oblong, obtuse; cells of seed coat transversely elongated, arranged in vertical rows; appendages ribbon-like band from transverse radial wall.

Fl. & Fr.: July-September.

Specimen Examined: Gaikwad 5101.

Distribution: Achirne and Malwan in Sindhudurg, Hatkhamba and Pavas in Ratnagiri district.

Note: Earlier it was known only from the type locality in Kerala.

Utricularia malabarica M.K. Janarthanam & A.N. Henry in J. Bombay nat. Hist. Soc. 86(1): 84. 1989; Janarthanam & Henry in Bladderworts of India, 68-69. 1992.

Herb; rhizoids glandular, branched. Leaves 3-nerved, obovate, rounded at apex. Traps globose; mouth basal with two simple subulate, glandular appendages. Racemes 2-5 cm long, 1-4 flowered; bracts basifixed, one nerved; pedicels winged, erect in anthesis and recurved in fruit. Calyx lobes ovate; upper lobe acuminate at apex; lower lobe 2-3-dentate at apex. Corolla blue with white tinge; upper lip truncate at apex; lower lip suborbicular, bigibbous at base and hairy in throat; spur slender, acute at apex. Capsule ovoid, uniformly membranous. Seeds ovoid; testa reticulate, cells elongated, smooth.

Fl. & Fr.: August-December.

Specimen Examined: Sardesai 289.

Distribution: Achirne, Malvan, Vaibhavwadi in Sindhudurg, Hatkhamba and Masebav in Ratnagiri district.

Note: Earlier it was known from Kerala, Karnataka and Goa.

Utricularia minutissima Vahl, Enum. Pl. 1: 204. 1804; Janarthanam & Henry in Bladderworts of India, 72-74. 1992. Cook, Aquatic and Wetland Plants of India, 241.1996.

Herb; rhizoids simple, glandular, rarely branched; stolons glandular, sparsely branched. Leaves linear, 1-nerved. Traps subglobose; mouth lateral, circular with one subulate appendage. Racemes 2-3 cm long, 1-4 flowered. Scales and bracts basifixed; pedicels terete, erect. Calyx lobes slightly unequal, ovate, hooded, papillose outside; upper lobe obtuse at apex; lower lobe notched at apex. Corolla pink with white tinge; upper lip oblong, ciliate along margins, rounded; lower lip shallowly 3-lobed, raised at base and hairy in throat; spur straight, horizontal, notched at apex. Capsule obliquely ovoid, compressed, uniformly membranous. Seeds globose, testa cells more or less isodiametric.

Fl. & Fr.: August-September.

Specimens Examined: Bhuskute 554, Sardesai 294.

Distribution: Achirne, Malvan, Shiroda in Sindhudurg, Pali, Hatkhamba, Masebav in

Ratnagiri, and Gonditola in Bhandara district.

Note: Earlier it was known from Goa, Karnataka, Kerala, Orissa, Tamil Nadu, and Uttar Pradesh.

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48. ADDITIONS TO THE GRASSES OF MAHARASHTRA

(*With three text-figures*)

During our survey of southwestern Maharashtra, three species of grasses were recorded for the first time for the state of Maharashtra. Short descriptions and illustrations have been provided for each of them. The specimens have been deposited in the Herbarium of Shivaji University, Kolhapur.

1. ***Bhidea fischeri*** P.V. Sreekumar & B.V. Shetty in Kew Bull. 42(3): 683-685. 1987. Fig. 1.

Annual, tufted, 15-35 cm tall, simple or branched; upper nodes villous, lower glabrous. Leaves lanceolate, 2-7 x 0.1-0.5 cm, acute. Racemes 2, 3-7 cm long; joints villous on one side. Sessile spikelets lanceolate, 9-10.5 mm long, awned; callus acute, densely silky villous. Lower glume lanceolate, 5-nerved, acuminate. Upper glume oblong, 3-lobed at apex with 4-5 mm long arista. Lower lemma ovate-lanceolate, 3-nerved, keels winged, epaleate. Upper lemma oblong-elliptic, 3-nerved, apex notched, awn geniculate, 55-65 mm long. Palea ovate, subacute. Lodicules 2. Stamen 2. Pedicels turbinate, villous on one side. Pedicelled spikelets empty, oblique, lanceolate, 8-10 mm long. Lower glume lanceolate, 7-9 nerved, acuminate. Upper glume lanceolate, 3-nerved, acuminate.

A rare grass growing on lateritic plateaux.

Fl. & Fr.: August-October.

Distribution: Ratnagiri: Pawas, *Salunkhe* 8227; Sindhudurg: Devgad, *Yadav* 8387.

2. ***Chloris pycnothrix*** Trin. Gram. Unifl. 234. 1824; Brito & Mathew in Mathew, Fl. Tamil. Carnatic 3: 1821. 1983 Fig. 2.

Annual, tufted, 15-55 cm tall, simple or branched. Leaves broadly linear, 1-10 x 0.2-0.6 cm, apex mucronate. Spikes 3-5, digitate, 2-5 cm long; rachis filiform. Spikelets closely pectinate, subsessile, ovate-lanceolate, 1.8-3.2 mm long. Lower glume ovate-lanceolate, 1-nerved, acuminate. Upper glume ovate-lanceolate, 1-nerved, acuminate. Lower lemma ovate-lanceolate, 1-nerved, apex notched, 2-toothed, awn capillary, 6-20 mm long. Palea linear-lanceolate, 2-nerved, acute. Rachilla slender, hairy, lodicules 2, stamens 3.

A rare grass growing near moist places.

Fl. & Fr.: September-December.

Distribution: Satara: Pusegaon, *Salunkhe* 8657.

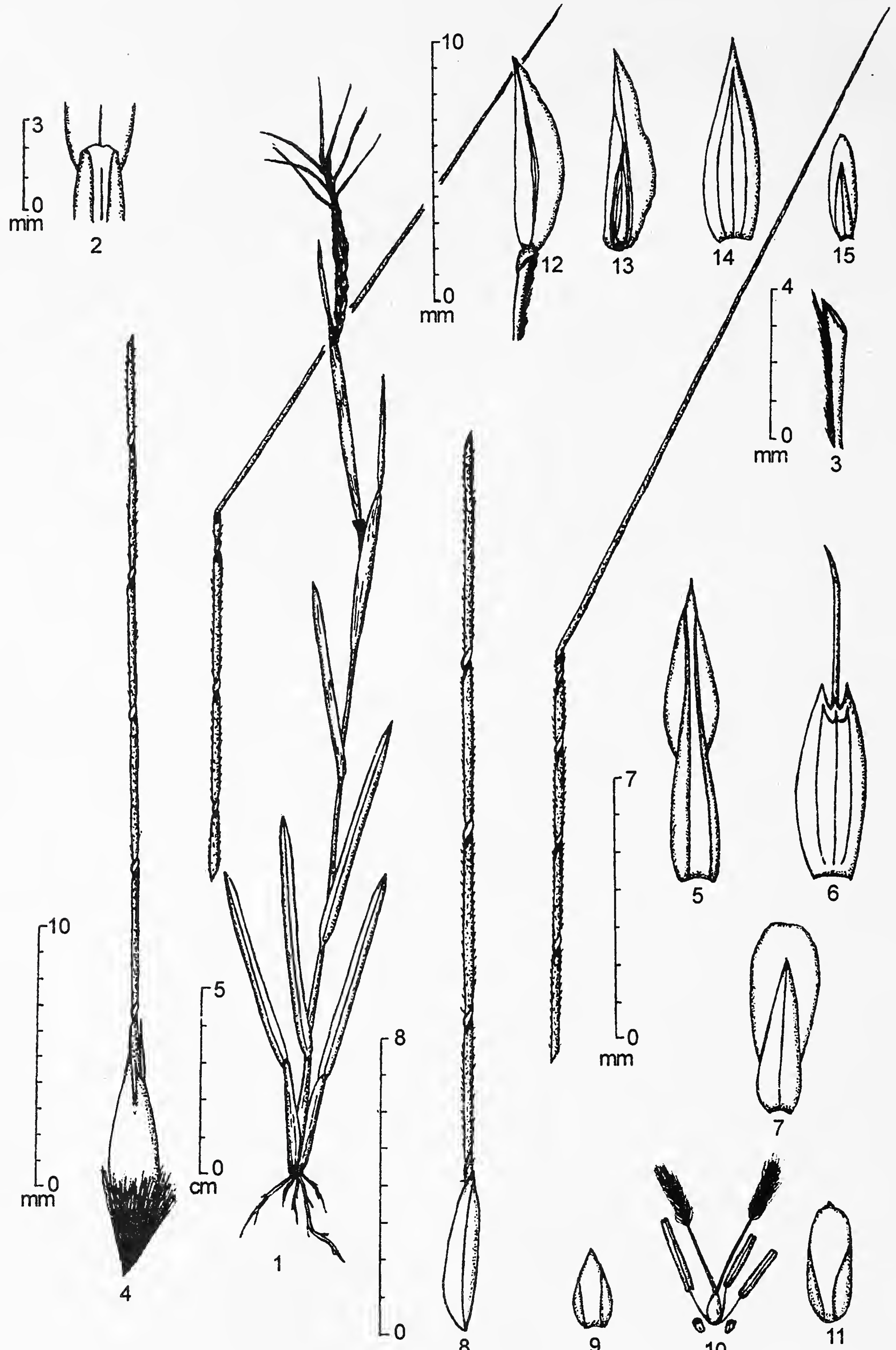

Fig. 1: *Bhidea fischeri* P.V. Sreekumar & B.V. Shetty; 1. Habit, 2. Ligule, 3. Joint, 4-11. Sessile spikelet: 4. Spikelet, 5. Lower glume, 6. Upper glume, 7. Lower lemma, 8. Upper lemma, 9. Palea, 10. Stamens and pistil, 11. Caryopsis, 12-15: Pedicelled spikelet: 12. Spikelet, 13. Lower glume, 14. Upper glume, 15. Lower lemma

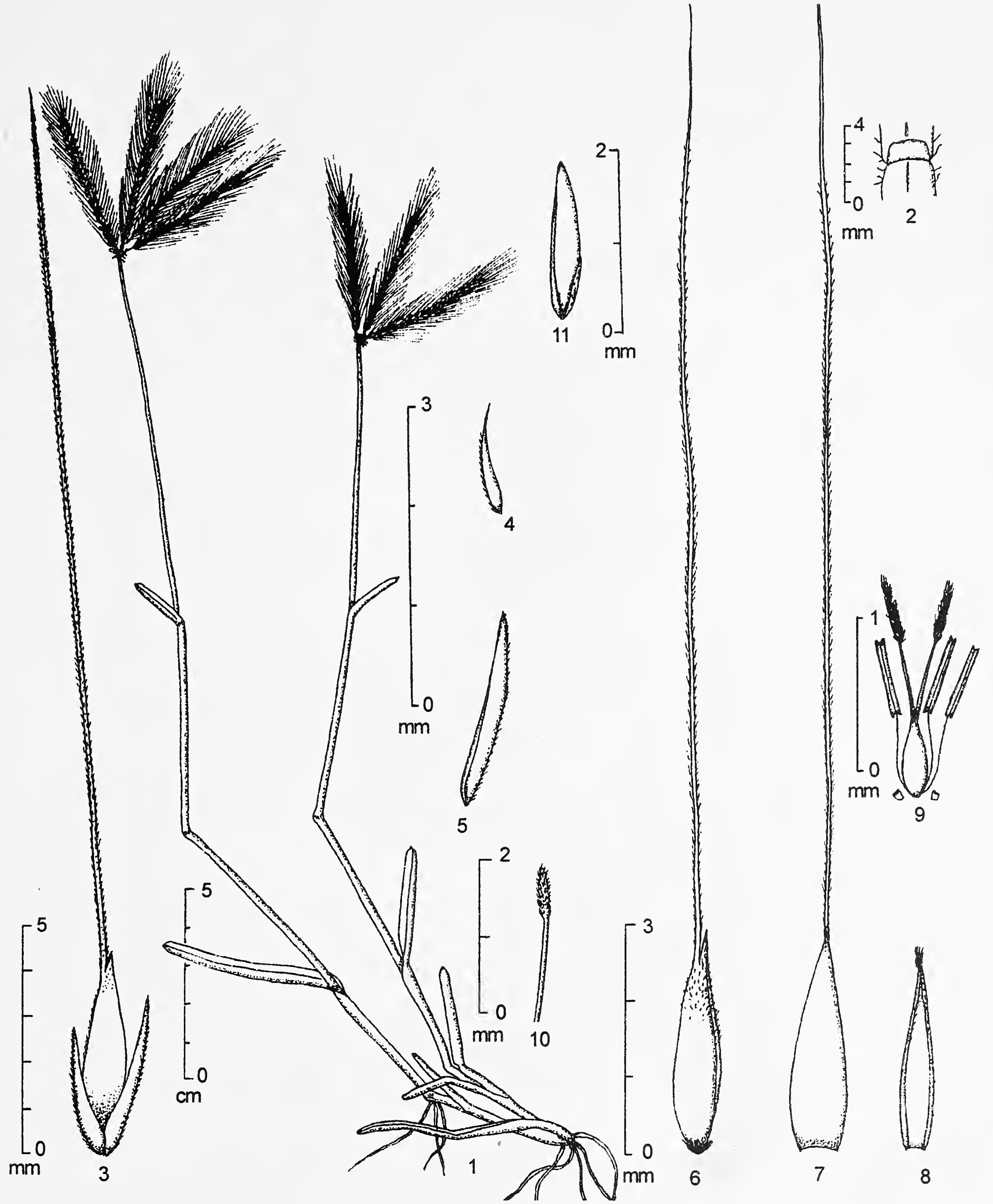

Fig. 2: *Chloris pycnothrix* Trin.; 1. Habit, 2. Ligule, 3. Spikelet, 4. Lower glume, 5. Upper glume, 6. Lemma - Lateral view, 7. Lemma - back view, 8. Palea, 9. Stamens & pistil, 10. Rachilla, 11. Caryopsis

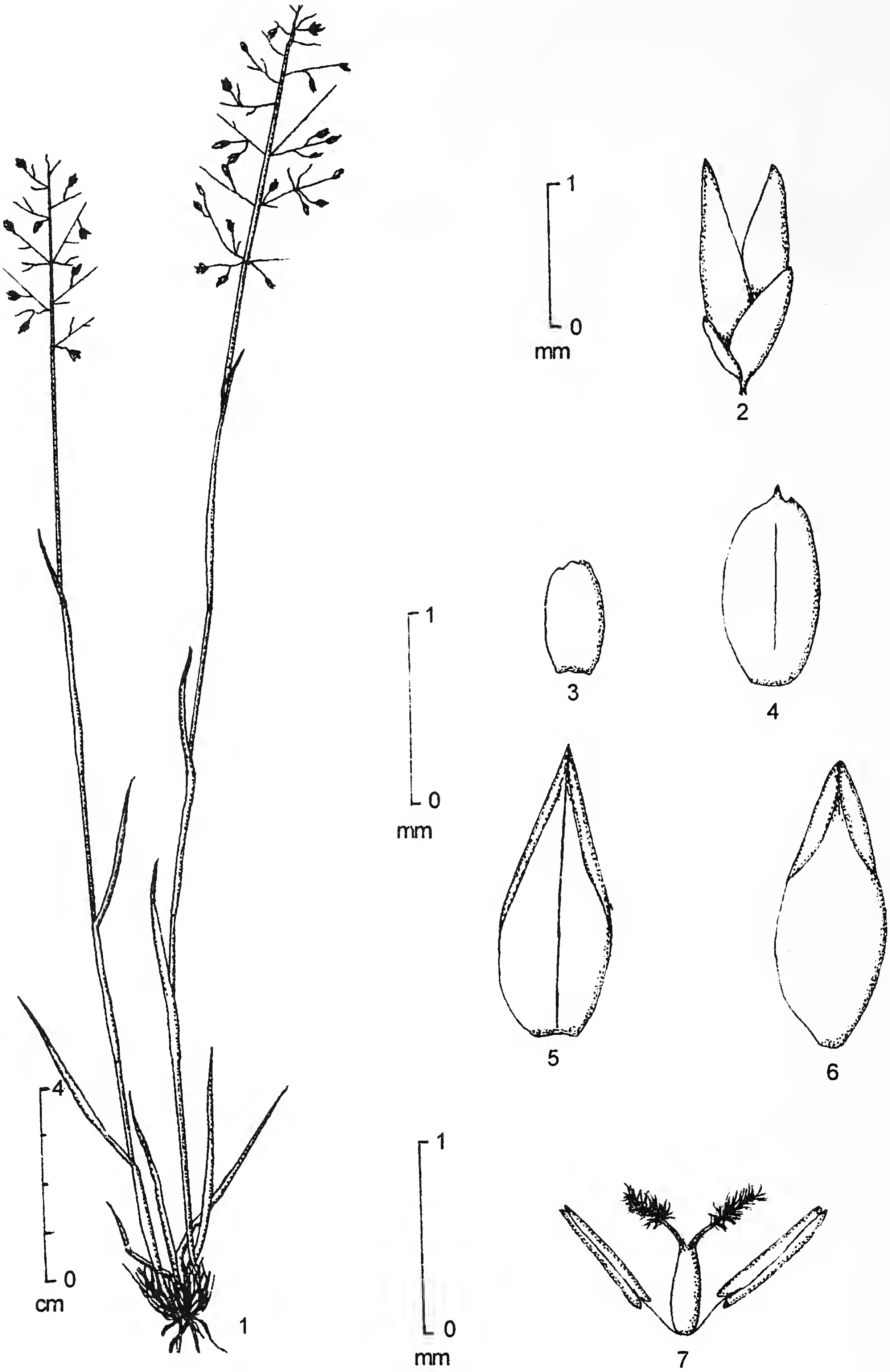

Fig. 3: *Sporobolus wallichi* Munro & Trin.; 1. Habit, 2. Spikelet, 3. Lower glume, 4. Upper glume, 5. Lemma, 6. Palea, 7. Stamens and pistil

3. ***Sporobolus wallichi*** Munro ex Trin. in J. Bot. 27: 171. 1889; Hook. f. Fl. Brit. Ind. 7: 248. 1896; Bor, Grass. Bur. Cey. Ind. Pak. 634. 1960. Mathew, Mat. Fl. Tamil. Carnatic 401. 1981. Fig. 3.

Perennial, tufted, 5-15 cm tall, simple or sparingly branched. Leaves linear, 5-15 cm long, acute. Panicles effuse, ovate-oblong, 4.5-8.5 x 2-3 cm, rachis slender, branches filiform, pedicels capillary. Spikelets lanceolate, 1-1.5 mm long. Lower glume oblong, nerveless, truncate. Upper glume oblong-elliptic, obscurely 1-nerved, acute. Lemma ovate-lanceolate, 1-nerved, acute. Palea ovate-oblong, obscurely nerved, subacute. Lodicules minute, stamens 2.

Rare in open grasslands on rocky soil.

Fl. & Fr.: July-September.

Distribution: Kolhapur: Shivaji University Campus, *Salunkhe* 8897.

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49. VEGETATION AND PHENODYNAMICS OF WETLANDS OF CENTRAL RAJASTHAN

(*With four text-figures*)

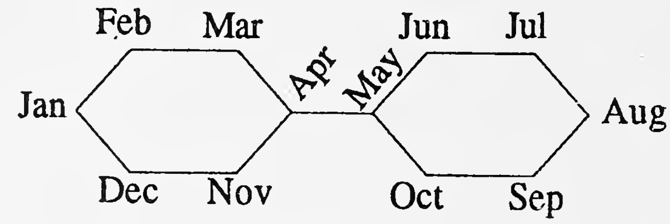
Studies of low-lying areas, including temporary ponds and pools, were initiated in India by Biswas and Calder (1937), Misra (1946), Ratnam and Joshi (1952), Mall (1961), Vyas (1964), Zutshi (1975), Bhardwaja (1980), Gopal (1986a, b), Bhardwaja and Gena (1987), Sharma K.C. and R. Sharma (1992), Sharma R. and K.C. Sharma (1992), and Anon. (1994). The gently sloping marginal area here exhibits a lush-green carpet of wetland plant species. The shallow middle area remains covered with water during the rainy season, getting exposed gradually to the slushy bottom stage and supporting hygrophilous vegetation during winter. This study reveals that wetlands bear transitional species interspersed with true aquatics, mesic terrestrials, hygro-halophytes, ephemerals, ephemeroids (grasses), poikilohydrics and dried bed plants (Vijay 1999, 2000). In these fluctuating ecosystems, patch dynamics is extremely important. Patches of relatively well-delineated areas of vegetation arise from the visible distribution of populations. These patches keep changing with time (Bohmer and Richter 1997). Some unique wetland plants like *Marsilea* spp., *Polygonum* spp., *Ammania baccifera*, *Bacopa monnieri*, *Cyperus* spp., *Scirpus* spp., grow in all zones of wetlands. Zones in vegetational mats occur in patches from the margins towards the centre. In cracks and crevices, *Glinus lotoides* and *Polygonum plebeium* grow profusely. It is well known that wetland plants show fluctuating phenology or phenodynamics, which is totally dependent on the availability of water. Centripetal movement and centrifugal movement of both water and vegetation is an interesting phenomenon of wetlands, and arborescent habit is rare due to fluctuating water levels with slushy beds containing no vegetation. In some small ditches

with slushy beds, dried bed species like *Glinus lotoides*, *Heliotropium* spp., and *Polygonum plebeium* occur. These wetland species growing in temporary ponds show "Terrestrialization": → Aquatic Marsh → Terrestrial (mesic) → Xeric (Kangas 1990).

Phenology (Kumar *et al.* 1980, Reich and Borchert 1982, Vijay 1997, 2000, Singh *et al.* 1998) of wetland plants comprising seed germination (Sg), vegetative growth (Vg), flowering (Fl), fruiting (Fr), seed maturation (Sm) and death (D) pattern were observed and recorded. Phenodynamics of some taxa are described.

Study Sites: The central Aravalli region of Ajmer was the study area. The Aravallis run about 692 km, northeast (near Delhi) to southeast of Gujarat (Palampur). The central Aravalli covers the entire Ajmer region (26° 25'-26° 35' N, 74° 37'-74° 42' E; 481.89 m above msl). The three study sites are Anasagar, Boodha-Pushkar and Lohagal wetland (Fig. 1).

Material and Methods: Vegetation analysis was done during 1997-2000. Field identifications were done with the help of extant Floras (Sharma 1958, Duthie 1903-20, Bhandari 1978, Cook 1996). Diphenyl ring was emphasized for phenological studies as indicated below:



Observations: In all, 102 species belonging to 33 families, comprising grasses, sedges, non leguminous, leguminous plants and lower plants, were recorded in the study area. As the water recedes, the marshy vegetation shows an interesting zonal distribution.

Fig. 2 reveals that the aquatic phase starts in July, wetland stage extends from November to February. The dry phase, beginning at the end

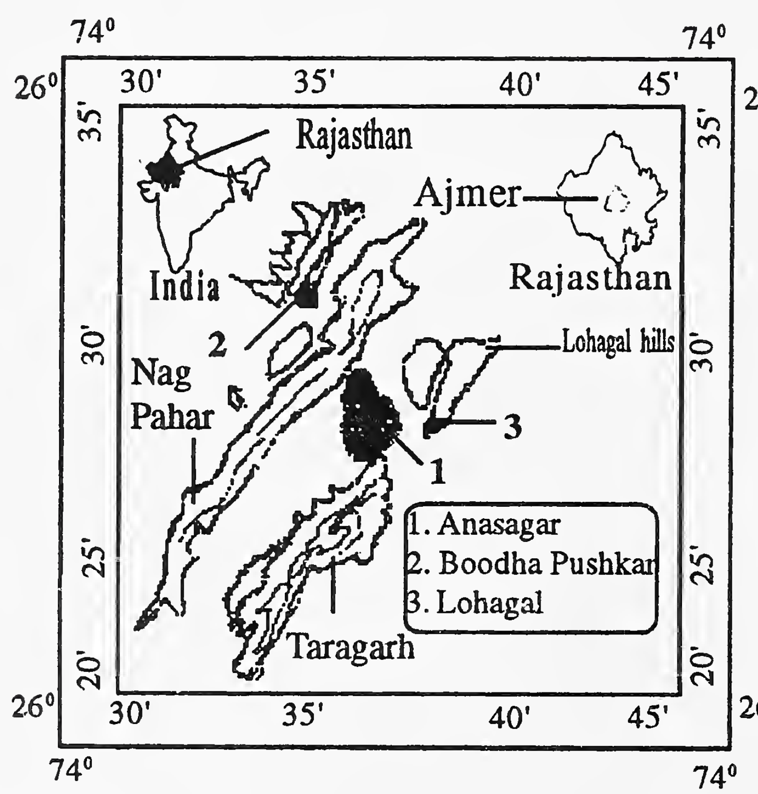
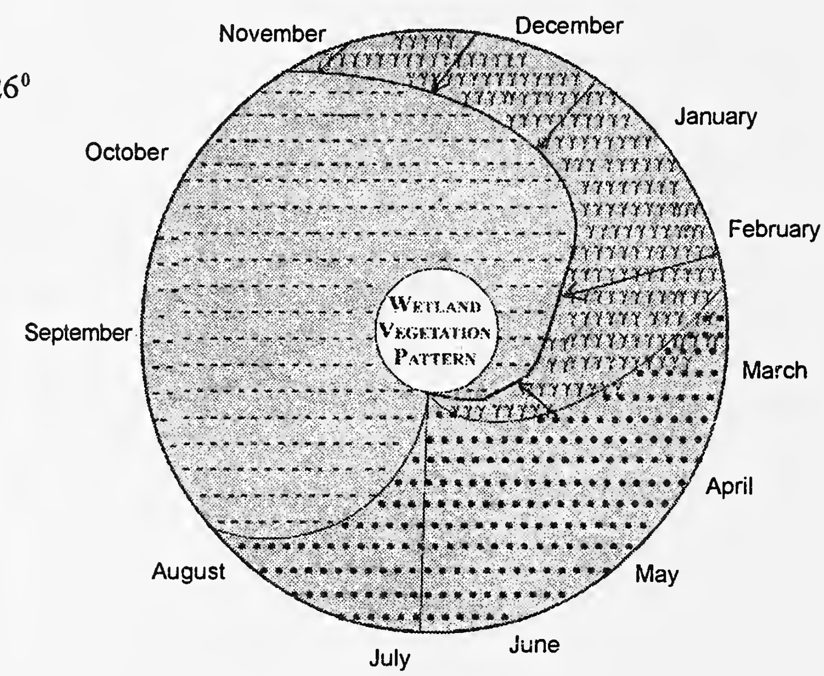


Fig. 1: Map of the study area



Legends: ------- Aquatic Phase;
ϒϒϒ Wetland Lush-green Phase;
●●●● - Dry Phase

Fig. 2: Showing Centripetal Movement Leading to Terrestrialization

Table 1: Species composition of Ajmer, central Rajasthan wetland

Sr. No.	Name of Plant	Family	Flowering Season	Locality
(A) Non -leguminous Forbs				
1.	*Aerva sanguinolenta* (Linn.) Blume, Bijdr	Amaranthaceae	Nov.-Dec.	Lohagal
2.	*Aeschynomene indica* Linn.	Fabaceae	Sep.-Nov.	Anasagar
3.	*Alternanthera paronychioides* A. St. Hillaire	Amaranthaceae	Nov.-Mar.	Common
4.	*Alternanthera sessilis* (Linn.) DC.	Amaranthaceae	Jul.-Oct. Feb.-Apr.	Common
5.	*Ammania baccifera* Linn.	Lythraceae	Sep.-Mar.	Common
6.	*Bacopa monnieri* (Linn.) Wettstein	Scrophulariaceae	Nov.-Apr.	Anasagar
7.	*Bergia ammanioides* Roxb.	Elatinaceae	Oct.-Jan.	Lohagal
8.	*Bergia polyantha* Sonder	Elatinaceae	Dec.-Mar.	Lohagal
9.	*Blumea lacera* (Burm.f.) DC.	Compositae	Sep.-Nov.	Common
10.	*Caesulia axillaris* Roxb.	Asteraceae	Nov.-Jan.	Anasagar
11.	*Chenopodium murale* Linn.	Chenopodiaceae	Oct.-Feb.	Anasagar
12.	*Chrozophora rottelari* (Guis) A. Juss ex Spreng.	Euphorbiaceae	Sep.-Dec.	Happy valley
13.	*Coldenia procumbens* Linn.	Boraginaceae	Jan.-Jun.	Kayad Pond
14.	*Cotula hemisphaerica* (Roxb.) Wall. ex. Benth. & Hook.	Asteraceae	Sep.-Jan.	Anasagar
15.	*Cressa cretica* Linn.	Convolvulaceae	Jan.-Jun.	Anasagar
16.	*Cyanotis axillaris* (Linn.) Sweet.	Commelinaceae	Sep.-Oct.	Lohagal
17.	*Dentella repens* (Linn.) Frost.	Rubiaceae	Dec.-Feb.	Anasagar
18.	*Digera arvensis* Linn.	Amaranthaceae	Aug.-Jan.	Anasagar
19.	*Dopatrium junceum* (Roxb.) F. Hamilton ex Bentham	Scrophulariaceae	Sep.-Dec.	Common
20.	*Eclipta prostrata* (Linn.) Linn.	Asteraceae	Jul.-Jan.	Common
21.	*Gisekia pharnaeoides* Linn.	Molluginaceae	Sep.-Jan.	Anasagar & Boodha Pushkar
22.	*Glinus lotoides* Linn.	Molluginaceae	Feb.-Jun.	Common
23.	*Gnaphalium indicum* Linn.	Asteraceae	Feb.-Jun.	Kayad Pond
24.	*Gnaphalium luteo-album* Linn.	Asteraceae	Nov.-Mar.	Common
25.	*Gnaphalium polycaulon* Pers.	Asteraceae	Sep.-Mar.	Foysagar
26.	*Gnaphalium pulvinatum* Delile.	Asteraceae	Mar.-May	Ghughra
27.	*Grangea maderaspatana* (Linn.) Poir.	Asteraceae	Dec.-Mar.	Anasagar
28.	*Heliotropium curassavicum* Linn.	Boraginaceae	Sep.-Jan.	Ghughra
29.	*Heliotropium indicum* Linn.	Boraginaceae	Sep.-Jan.	Anasagar
30.	*Heliotropium strigosum* Willd.	Boraginaceae	Oct.-Dec.	Anasagar
31.	*Heliotropium supinum* Linn.	Boraginaceae	Jan.-Dec.	Anasagar
32.	*Heliotropium ovalifolium* Forsk.	Boraginaceae	Mar.-Jun.	Ghughra
33.	*Hoppea dichotoma* Willd.	Haloragaceae	Oct.-Dec.	Lohagal
34.	*Hygrophila schulli* (F. Hamilton) M.R. et S.M. Almeida	Acanthaceae	Sep.-Dec.	Ghughra
35.	*Ipomea aquatica* Forsk.	Convolvulaceae	Oct.-Jan.	Ajmer city
36.	*Ipomea fistulosa* Martius ex. Choisy	Convolvulaceae	Oct.-Jan.	Ajmer city
37.	*Juncus bufonius* Linn.	Juncaceae	Sep.-Feb.	Common
38.	*Justicia quinquangularis* J.G. Konig ex Roxburgh	Acanthaceae	Dec.-Feb.	Common
39.	*Launaea procumbens* (Roxb) Ramayya & Rajgopal	Asteraceae	Mar.-Apr.	Common
40.	*Limnophila heterophylla* (Roxb.) Bentham	Scrophulariaceae	Oct.-Apr.	Ghughra
41.	*Malva parviflora* Linn.	Malvaceae	Oct.-Feb.	Lohagal
42.	*Mentha* sp. (?)	Labiatae	Nov.-Mar.	Boodha Pushkar
43.	*Monochoria vaginalis* (N.L. Burman) Kunth	Pontederiaceae	Dec.-Mar.	Anasagar
44.	*Nicotiana plumbaginifolia* Viv.	Solanaceae	Nov.-Mar.	Happy Valley

Table 1: Species composition of Ajmer, central Rajasthan wetland (*contd.*)

Sr. No.	Name of Plant	Family	Flowering Season	Locality
45.	*Oldenlandia diffusa* (Willdenow) Roxb.	Rubiaceae	Sep.-Dec.	Lohagal
46.	*Oxalis corniculata* Linn.	Oxalidaceae	Dec.-Feb.	Anasagar
47.	*Peplidium maritimum* (Linn. f.) Aschers.	Scrophulariaceae	Dec.-Mar.	Anasagar
48.	*Phyla nodiflora* (Linn.) Greene	Verbenaceae	Oct.-Mar.	Common
49.	*Polygonum glabrum* Willd.	Polygonaceae	Jul.-Oct.	Boodha Pushkar
50.	*Polygonum plebeium* Willd.	Polygonaceae	Oct.-Nov.	Common
51.	*Portulaca meridiana* Linn.	Portulacaceae	Sep.-Jan.	Anasagar
52.	*Portulaca oleracea* Linn.	Portulacaceae	Sep.-Jan.	Lohagal
53.	*Portulaca quadrifida* Linn.	Portulacaceae	Sep.-Jan.	Anasagar
54.	*Potentilla supina* Linn.	Rosaceae	Jan.-Apr.	Common
55.	*Pulicaria foliosa* A.P. de Condolle	Asteraceae	Sep.-Nov.	Anasagar
56.	*Ranunculus scleratus* Linn.	Ranunculaceae	Oct.-Dec.	Anasagar
57.	*Rumex dentatus* Linn.	Polygonaceae	Sep.-Dec.	Anasagar
58.	*Spergula fallax* (Lowe.) Krause	Caryophyllaceae	Nov.-Mar.	Anasagar & Lohagal
59.	*Sphaeranthus indicus* Linn.	Asteraceae	Jan.-Apr.	Anasagar
60.	*Suaeda fruticosa* (Linn.) Forsk.	Chenopodiaceae	Mar.-Jun.	Anasagar
61.	*Tamarix dioica* Roxb.	Tamaricaceae	Dec.-Jan.	Anasagar
62.	*Trianthema crystallina* Roxb.	Aizoaceae	Oct.-Feb.	Anasagar
63.	*Trianthema portulacastrum* Linn.	Aizoaceae	Oct.-Feb.	Boodha Pushkar
64.	*Typha domingensis* Persoon	Typhaceae	Oct.-Feb.	Anasagar
65.	*Typha elephantiana* Roxb.	Typhaceae	Oct.-Feb.	Common
66.	*Verbascum chinense* (Linn.) Santapau	Scrophulariaceae	Jan.-Apr.	Common
67.	*Xanthium strumarium* Linn.	Asteraceae	Sep.-Feb.	Common
(B) Leguminous Forbs				
1.	*Sesbania bispinosa* (Jacq.) W.F. Wight	Fabaceae	Sep.-Nov.	Anasagar
2.	*Trigonella occulta* Raffenau-Delile.	Papilionaceae	Feb.-Mar.	Common
(C)	**Grasses**			
1.	*Arundo donax* Linn.	Poaceae	Sep.-Dec.	Pal Beechla
2.	*Brachiaria ramosa* (Linn.) Stapf	Poaceae	Aug.-Oct.	Common
3.	*Cenchrus biflorus* Roxb.	Poaceae	Aug.-Oct.	Common
4.	*Chloris virgata* Sw.	Poaceae	Aug.-Oct.	Common
5.	*Cynodon dactylon* (Linn.) Pers.	Poaceae	Jan.-Dec.	Common
6.	*Dicanthium annulatum* (Forsskal) Stapf	Poaceae	Sep.-Feb.	Common
7.	*Digitaria ciliaris* (Rotzius) Koeler	Poaceae	Nov.-Dec.	Common
8.	*Digitaria setigera* Roth. ex Roemer et. Schulf.	Poaceae	Sep.-Dec.	Common
9.	*Echinochloa colonum* (Linn.) Link.	Poaceae	Sep.-Feb.	Common
10.	*Eragrostris pilosa* (Linn.) Palisot de Beauvois	Poaceae	Jan.-Dec.	Common
11.	*Fimbristylis tomentosa* Vahl	Poaceae	Nov.-Jan.	Common
12.	*Paspalidium geminatum* (Forsk.) Stapf	Poaceae	Jan.-Oct.	Boodha Pushkar & Anasagar
13.	*Perotis indica* (Linn.) O. Ktze.	Poaceae	Jan.-Dec.	Common
14.	*Phragmitis vallatoria* (Linn.) Veldkomp.	Poaceae	Aug.-Jan.	Ajmer city
15.	*Poa palustris* Linn.	Poaceae	Nov.-Dec.	Common
16.	*Saccharum bengalense* Retz.	Poaceae	Jan.-Dec.	Anasagar
17.	*Setaria verticillata* (Linn.) P. Beauv.	Poaceae	Aug.-Oct	Common
18.	*Polypogon monspeliensis* (Linn.) Desf.	Poaceae	Dec.-Feb.	Anasagar

Table 1: Species composition of Ajmer, central Rajasthan wetland (*contd.*)

Sr. No.	Name of Plant	Family	Flowering Season	Locality
(D) Sedges				
1.	*Cyperus compressus* Linn.	Cyperaceae	July-Oct.	Common
2.	*Cyperus diformis* Linn.	Cyperaceae	Oct.-Nov.	Common
3.	*Cyperus rotundus* Linn.	Cyperaceae	Oct.-Mar.	Common
4.	*Cyperus setaceus* Retzius	Cyperaceae	Nov.-Mar.	Common
5.	*Cyperus triceps* (Rottb.) Endlicher	Cyperaceae	Sep.-Mar.	Common
6.	*Cyperus alopecuroides* Rottb.	Cyperaceae	Oct.-Mar.	Anasagar
7.	*Cyperus involucratus* Rottb.	Cyperaceae	Sep.-Nov.	Common
8.	*Cyperus atkinsonii* C.B. Clarke	Cyperaceae	Oct.-Mar.	Common
9.	*Cyperus bulbosus* Vahl.	Cyperaceae	Oct.-Mar.	Boodha Pushkar
10.	*Eleocharis acutangula* (Roxb.) Schultes	Cyperaceae	Sep.-Feb.	Common
11.	*Scirpus lateriflorus* Gmel.	Cyperaceae	Aug.-Dec.	Anasagar
(E) Archegoniates Cryptogams				
1.	*Equisetum ramosissimum* Desfontaines	Equisetaceae		Nasirabad Valley
2.	*Marsilea aegyptiaca* Willdenow	Marsileaceae		Lohagal
3.	*Marsilea minuta* Linn.	Marsileaceae		Anasagar
4.	*Riccia crystallina* (?)	Ricciaceae		Anasagar

of February, continues till June. The maximum vegetation occurs in medium water conditions when terrestrialization is initiated and sequence of vegetation is affected. The gentle sloping marginal zone exhibits a carpet of wetland species, with 'terrestrialization' occurring at the middle zone, which is covered with water during the rainy season, gradually getting exposed in winter, supporting lush-green marshy vegetation. During the dry months the water level recedes further and at its minimum the ponds and puddles support characteristic vegetation consisting of *Glinus lotoides*, *Alternanthera sessilis*, *Polygonum plebeium*, *Paspalidium geminatum*, *Ammania baccifera*, *Eclipta prostrata*, *Gnaphalium pulvinatum*, *Bacopa monnieri*, *Phyla nodiflora*, *Grangea madraspatana*, *Polypogon monspeliensis*, *Portulaca* spp., and *Cynodon dactylon*. Some hygro-halophytes, such as *Heliotropium supinum*, *Suaeda fruticosa* and *Cressa cretica* (Table 1), also appear on the exposed soil.

Phenodynamics: Phenological observations of *Heliotropium curassavicum*, *Glinus lotoides*, *Cressa cretica* and *Ammania baccifera* inhabiting the wetlands were recorded during the study period (1997-99), (Figs 4A-D).

From Fig. 4 (A-D) it is evident that phenology fluctuates with the availability of water, humidity and temperature. Striking pheno-variations/pheno-rhythms were observed for the period under study, which emphasizes variations in phenophases corresponding to climatic variations in the terrestrialization process. It may be mentioned that 1997 was a period of excess rainfall at Ajmer, as indicated in the ombrotherms for 1997-99 (Fig. 3).

A. *Heliotropium curassavicum* – a soft soil plant, with germination of seed generally in November and December. But in 1997, no germination occurred due to excessive flooding. In April and May 1998, germination occurred, but flowering, fruiting and seed maturation was not completed because of heavy rainfall in July (Fig. 4A)

B. *Glinus lotoides* – A dry bed or cracked soil plant of the wetlands. It showed seed germination only in June 1998. In 1997-98 and up to February 1999, *Glinus lotoides* was totally absent from these sites (Fig. 4B)

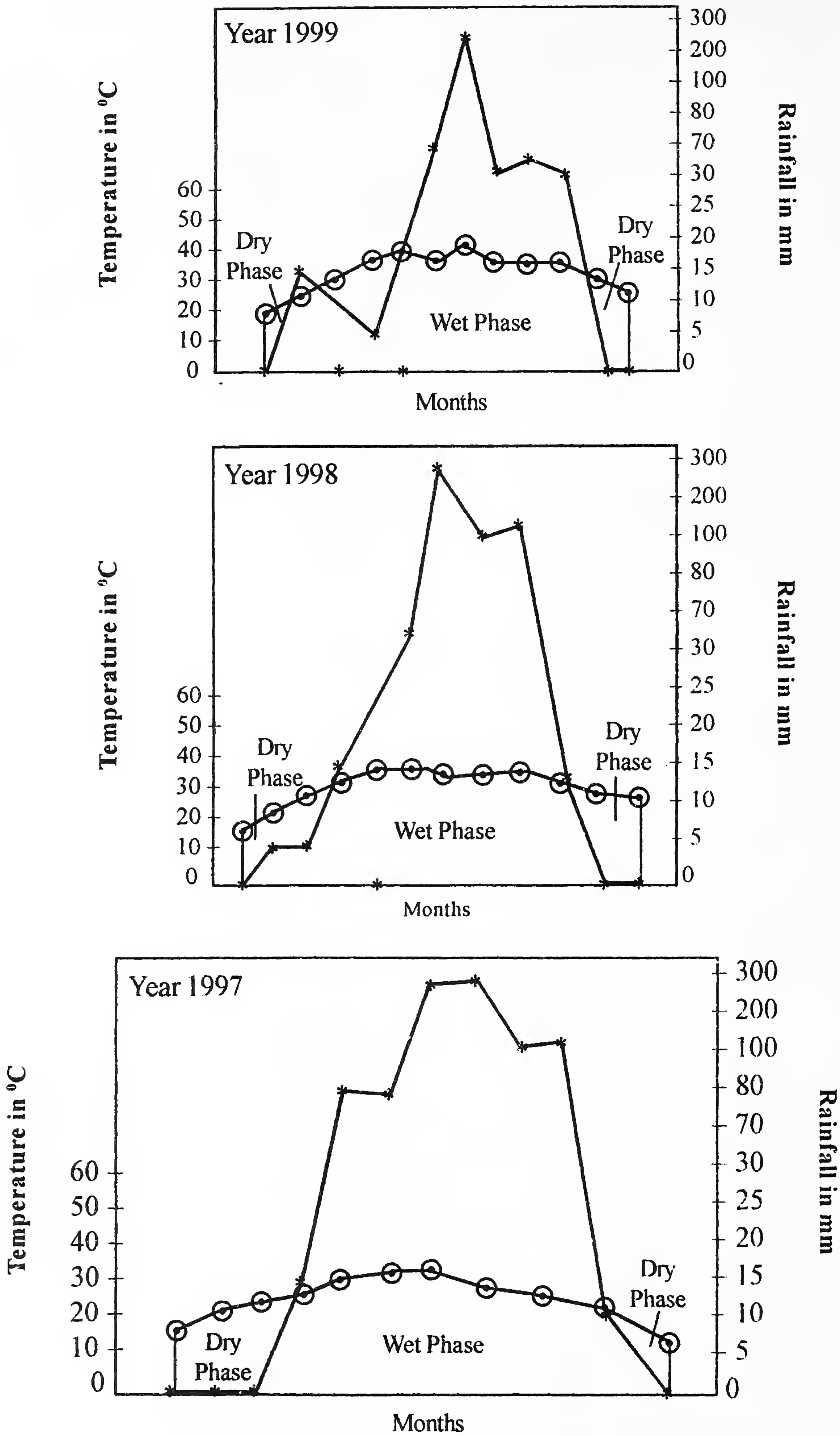
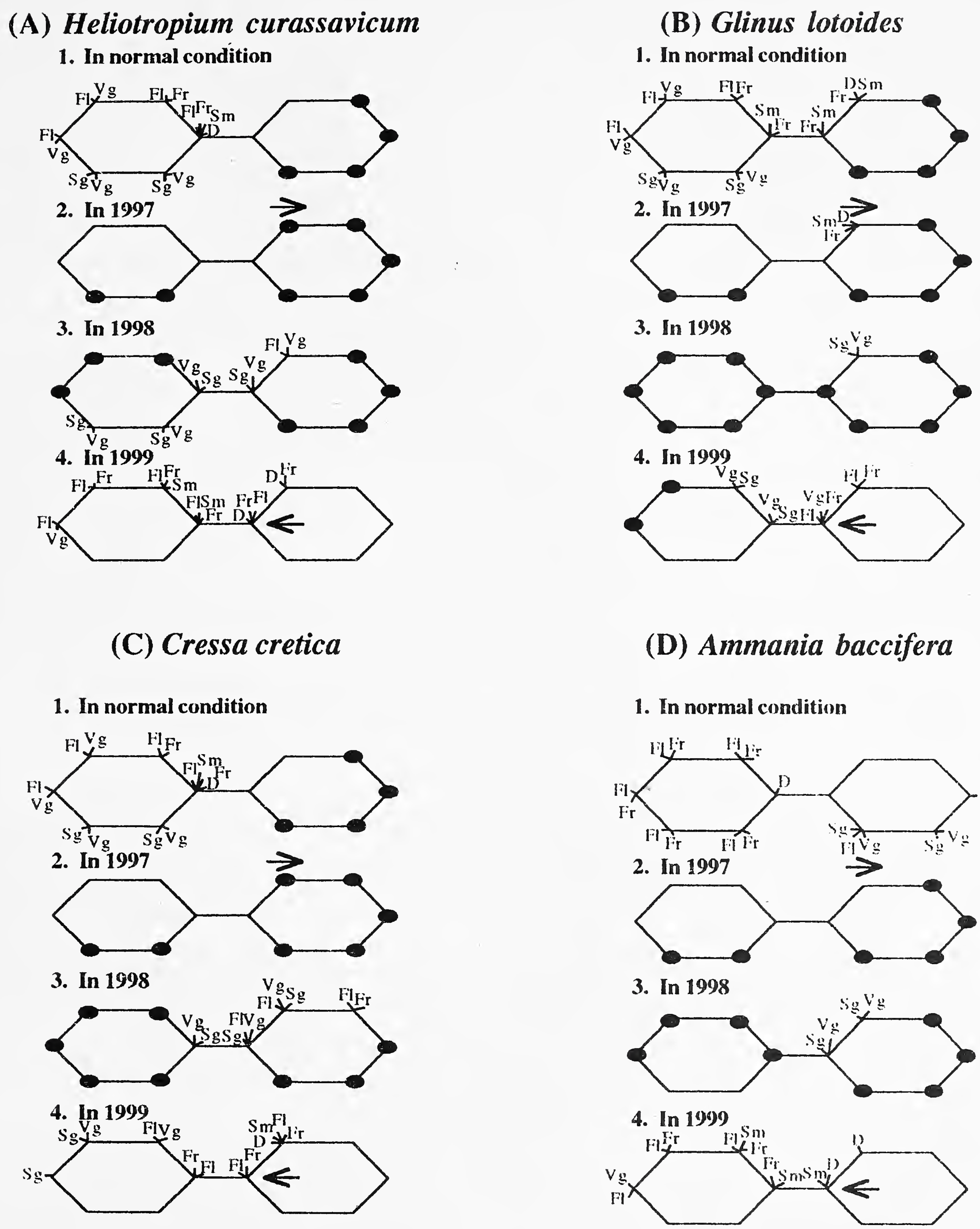


Fig. 3: Ombrothermic diagrams showing wet and dry phase during the study period



Abbreviations: Sg-Seed germination; Vg-Vegetative growth; Fl-Flowering; Fr-Fruiting; Sm-Seed maturation; D-Death; ● - Water Flooding

Fig. 4: A-D Phenodynamics of some Wetland plants

C. *Cressa cretica* – Under normal conditions, phenology starts from November, but in 1997 germination did not occur the whole year due to flooding and continued till March 1998. In April 1998, seed germination and vegetative growth started, but flowering and fruiting did not occur due to flooding till December 1998. Seed germination began only in January 1999 (Fig. 4C)

D. *Ammania baccifera* – Characterized by various colours during growth with seed germination in August. In 1997, however, no seed germination occurred in August and this continued till April of the next year, i.e. 1998. Germination took place in May 1998, and reflooding in July 1998 permitted the plant to reappear in November 1998 (Fig. 4D).

Discussion: Wetlands are highly productive ecosystems with prolific biodiversity. They are significant in terms of water purification, microclimatic regulation, locking and storing nutrients, recharging of water table and as habitats for wildlife. The extant degradation of wetlands calls for intensive ameliorative measures. Striking pheno-variations and pheno-rhythms were observed, indicating the impact of microclimatic factors.

Cultivation, human activities and land encroachment for building purposes poses various threats to wetland vegetation. Ponds, puddles and water reservoirs supporting these wetland plants are gradually being eliminated in the study area, due to cultivation at Boodha Pushkar, urbanisation, waste disposal and water pollution due to professional washing at Anasagar, and growth of *Prosopis chilensis* at Lohagal site. This calls for a concerted effort to save wetland vegetation in and around cities like Ajmer. We hope that this study will succeed in drawing attention to this need.

October 1, 2001

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50. *TYPHONIUM HORSFIELDII* (MIQ.) STEENIS, FAMILY ARACEAE, A NEW REPORT FOR INDIA

(*With one text-figure*)

While revising the Indian Araceae, it was found that a specimen at CAL which had been collected in Mizoram by B. Godfrey and labelled as *Arisaema tortuosum* (Wall.) Schott var. *curvatum* (Roxb.) Engl. had been later determined as *Typhonium horsfieldii* (Miq.) Steenis by Nicolson, a well-known aroidologist. A perusal of literature reveals that this species is confined to Java in Indonesia. As the specimen in question is from Mizoram, the species becomes an addition to the flora of India. A detailed description and an illustration (Fig. 1) are provided to facilitate identification.

Typhonium horsfieldii (Miq.) Steenis in Bull. Jard. Bot., Buitenzorg Ser. 3, 17: 403. 1948; Backer & Bakh. f., Fl. Java 3: 123. 1968. *Sauromatum horsfieldii* Miq., Fl. Ind.-Bat. 3: 196. 1856; Engl. in A. DC., Monogr. Phan. 2: 571. 1879. Type: Java (U). *Typhonium fallax* N.E. Br. in J. Linn. Soc., Bot. 18: 260. 1880; Engl., Pflanzenr. (IV. 23 F) 73: 121, f. 17 F - N. 1920. *Heterostalis pedata* Schott in Ann. Mus. Bot. Lugduno-Batavum 1: 278. 1864, non *Typhonium pedatum* Schott 1857. *Typhonium pedatum* sensu Engl. in A. DC., Monogr. Phan. 2: 613. 1879, non Schott 1857.

Cormous herb; corm *c.* 0.9 x 0.8 cm, subglobose. Cataphylls 3-3.5 cm long. Leaves pedatisect; petioles 10-40 cm long, sheathing; leaflets 7-9, sessile, lanceolate, acuminate; middle leaflet 5.5-7.5 x 0.6-1 cm; lateral leaflets gradually becoming smaller, 1.2-5.5 cm long. Peduncle 4-20 cm long; spathe 8-10 cm long; tube 2-3 cm long, oblong, convolute; limb 6-7 x 2-2.5 cm, oblong-lanceolate, cuspidate. Spadix 5.8-10 cm long. Pistillate-flowered portion 0.2-1 x 0.4-0.6 cm. Neuter-flowered portion 2-2.2 cm long followed by stipe *c.* 7 mm long. Staminate-flowered portion 0.7-1 x *c.* 0.3 cm, terminating in a stipitate appendix. Pistillate flowers *c.* 1 x 0.5-0.8 mm, dense; ovary ovoid, 2-ovuled; stigma capitate, coronate. Neuters

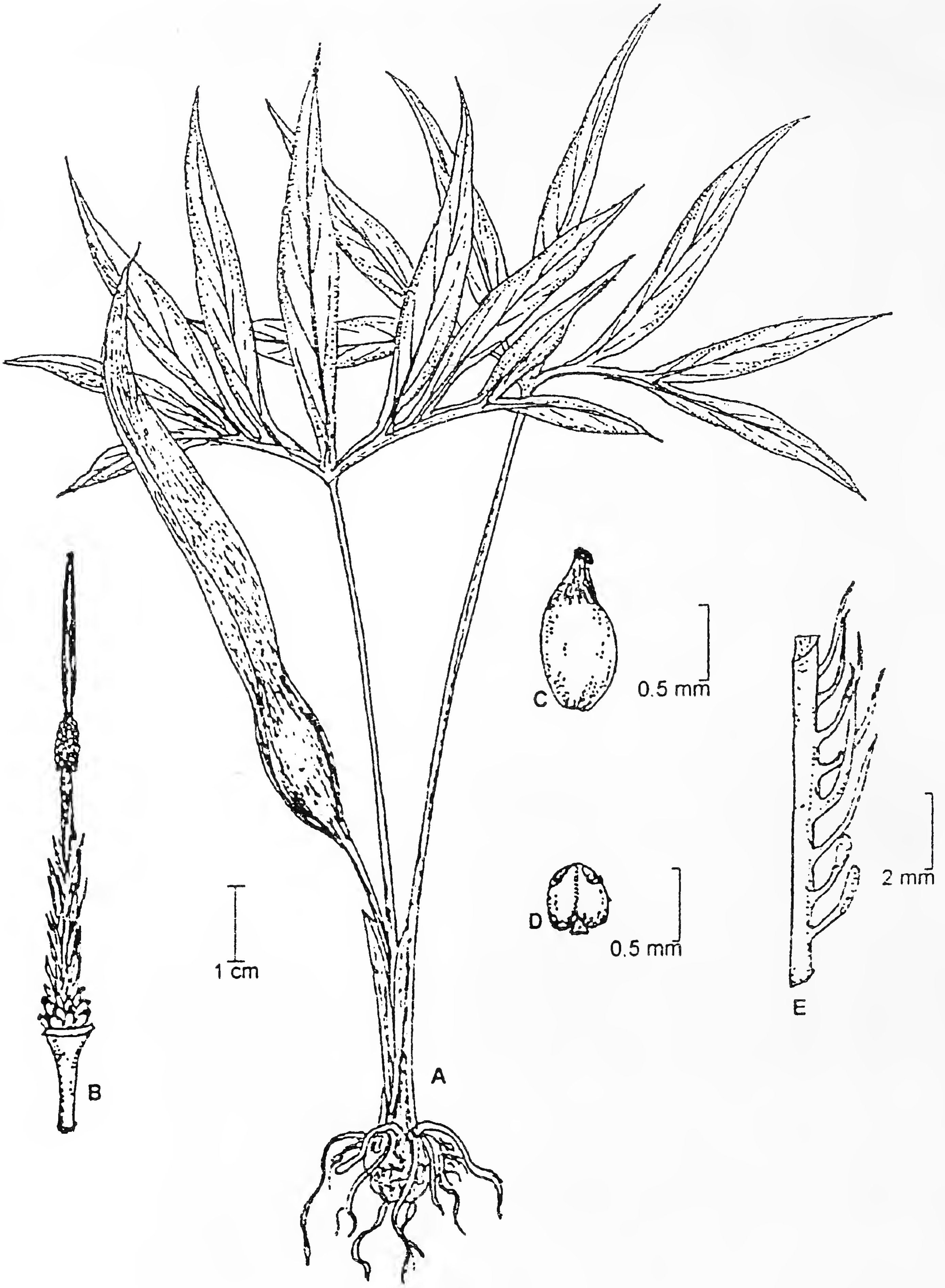

Fig. 1: *Typhonium horsfieldii* (Miq.) Steenis; A. Habit, B. Spadix, C. Pistillate flower, D. Staminate flower, E. Neuters

elongate-clavate at base, 1.5-2.5 mm long, linear above, 4-5.5 mm long. Staminate flowers *c.* 0.5 mm long; anthers broadly ovate, shortly stalked, dehiscing by apical slits. Appendix 2.2-5 cm long, cylindrical.

Fl. & Fr.: Not known.

Distribution: INDIA: Mizoram. WORLD: Indonesia (Java).

Specimen examined: MIZORAM: Lushai hills, Aijal, B. Godfrey 527 (CAL).

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51. LECTOTYPIFICATION OF *POLYSTICHUM SQUARROSUM* (D. DON) FEE VAR. *BEDDOMEI* MANICKAM & RAJKUMAR, FAMILY DRYOPTERIDACEAE

Polystichum squarrosum (D. Don) Fee is a tropical fern with morphological diversity and taxonomic complexity. Rajkumar and Manickam (*Pak. J. Biol*, 2(3): 755-758, 1999), while analysing the spore morphology of *Polystichum squarrosum* have observed two distinct types of perine and have construed them as two varieties. The specimen with winged smooth hyaline perine have been placed under var. *beddomei* and the crescent dark brown perined specimens have been placed under var. *squarrosum*. Of 20 specimens, they have found 5 specimens (XCH 241, 350, 419, 897, 922) to be var. *beddomei* and the rest (XCH 9, 291, 307, 319, 320, 415, 434, 443, 470, 561, 684, 713, 738, 824, 867) to be var. *squarrosum*. Unfortunately, var. *beddomei* has not been typified. Hence, as per the ICBN rules it is lectotyped here. The lectotype has been selected from the specimens preserved at St. Xavier's College Herbarium (XCH), Palayamkottai.

Polystichum squarrosum (D.Don) Fee var. *beddomei* Manickam & Rajkumar, Pak. J. Biol. Sci, 2(3): 755-758, Fig. 3a (1999).

Lectotype: India, Tamil Nadu, Nilgiri Hills, Thottabetta (2,650 m), 24.x.1991, Manickam, XCH 419.

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52. A COMPARATIVE STUDY ON THE REPRODUCTIVE BIOLOGY OF THREE INDIAN SPECIES OF *MARSILEA*

A comparative reproductive biological study was conducted on three Indian *Marsilea* species of the *coromandeliana* group. The species having monomorphic megaspores showed microsporal aberrations, while those with megasporal aberrations had normal microspores.

Release mechanism of the mega and microspores from their sporangia was different in these species.

Marsilea L., Family Marsileaceae, is a thoroughly investigated genus of amphibious pteridophytes. It is the most versatile fern genus morphologically and ecologically, while its reproductive biology exhibits a close correspondence to its morphological and ecological plasticity, unlike the other two genera of the family — *Regnellidium* and *Pilularia* — as well as other heterosporous aquatic ferns. The different habitats and ecological adaptations from aquatic to sub-terrestrial, terrestrial to extreme xerophyte fully concurs with a wide spectrum of reproductive mechanism (Bhardwaja 1966). Gupta (1962) and Bhardwaja (1980) have published facets of the biology of this genus.

Three Indian species of *Marsilea* L., namely *Marsilea coromandeliana* Willd., *M. kedarmalii* (Bhardwaja *et al.* 1994) and *M. shashibalii* (Bhardwaja *et al.* 2000) were selected for this study. Ripe sporocarps of the species were collected. Five sporocarps of each species were scarified and kept for germination in a petri dish containing tap water. The various stages of sexual reproduction in the three species of *Marsilea* from sorophore extrusion to sporeling formation were constantly monitored with a stereoscopic binocular microscope.

For sporal studies, ripe sporocarps of these plants were boiled in a 5% aqueous solution of potassium hydroxide (KOH) and allowed to cool to burst open the sporocarps. The sori from these ruptured sporocarps were squashed in acetocarmine. The sporangial contents were classified as per Loyal and Kumar (1979).

Spore morphology of all the three species of *Marsilea* L. shows that the megaspores are somewhat longer than broad, ellipsoidal or ovate in general outline. Megaspores of *Marsilea coromandeliana* Willd. exhibit polymorphism, which has not been found in the other two closely allied species — *M. kedarmalii* Bhardwaja *et al.* and *M. shashibalii* Bhardwaja *et al.* Megaspore polymorphism in *Marsilea coromandeliana* Willd. matches that of *Isoetes coromandeliana* L., another heterosporous pteridophyte (Gena 1980).

It was observed that while normal monomorphic megaspores are found in *M. kedarmalii* Bhardwaja *et al.* and *M. shashibalii* Bhardwaja *et al.* their microsporangia exhibit microsporangial aberrations. Along with the normal large and small microspores within the microsporangium, aberrant microspores were found in the microsporangia. [Microsporangium possesses normal microspores, monads and deformed spores.] This has also been reported earlier in *M. hirsuta* R.Br. by Feller (1953) and in *M. minuta* L. by Loyal and Kumar (1979). *M. coromandeliana* Willd. which is known to have polymorphic megaspores, showed normal monomorphic microspores. All the 64 microspores present in a microsporangium of *M. coromandeliana* Willd. were found to be of uniform size and shape.

Detailed observations regarding spore liberation, development of male and female gametes and sporeling formation have been recorded in Tables 1 and 2. Interspecific differences regarding these aspects of reproductive biology were seen.

Gupta and Bhardwaja (1956) have done considerable research on the morphology and systematics of the genus *Marsilea* L. Gupta (1962) has studied variations in size and shape of the vegetative organs and differentiation into xerophytic and hydrophytic forms in his monograph on *Marsilea* L. The occurrence of microsporangia lacking normal microspores may be attributed to the fact that increasing dryness of the habitat leads to the formation of larger number of megasporangia (Bhardwaja 1966). The available nutrition is thus utilized maximally in the formation of megaspores, and smaller

Table 1: Comparison of gametophyte and sporeling development in the three *Marsilea* species

S. No	Parameters	*Marsilea coromandeliana*	*Marsilea kedarmalii*	*Marsilea shashibalii*
1	Extrusion of sorophore (hr)	2	1	1.5
2	Length of sorophore (cm)	2.5-3	3-5	2-2.5
3	No. of sori / sporocarp	8-12	10-15	7-11
4	No. of microspores/microsporangium	64	64 (16-24 normal spores)	64 (12-24 normal spores)
5	No. megaspores/sporocarp (Average)	70	91	54
6	Release of megaspores (hr)	8-10	2-3	6-8
7	Sporal morphology			
	a) Microspores	Normal	Aberrant	Absent
	b) Megaspores	Aberrant	Normal	Normal
8	Release of microspores (hr)	10-12	3-4	6-8
9	Bursting of microspores (hr)	12-14	6-10	9-12
10	Female gametophyte development (hr) (Formation of green apical mound)	12-14	10-12	12-14
11	Spore germination %			
	a) Microspores	60	70	65
	b) Megaspores	42.4	46.5	32.4
12	Dark germination %			
	a) Microspores	Absent	40	25
	b) Megaspores	Absent	20	Absent
13	Rhizoids on developing female gametophyte	Absent	Present	Present
14	Development of archegonium (hr)	18-20	16-18	18-20
15	Liberation of antherozoids (hr)	20-22	18-20	20-22
16	Sporeling initiation (hr)	38-40	26-32	34-38
17	First leaf initiation (hr)	64-70	48-52	54-58
18	First root initiation (hr)	72-80	58-68	72-78
19	Development of sporophyte from isolated megaspore	Nil	14.2 %	Nil

Table 2: Sporocarp contents of three *Marsilea* species

Sl. No.	Parameters	*Marsilea coromandeliana*	*Marsilea kedarmalii*	*Marsilea shashibalii*
1	Number of Sori/ sporocarp			
	Range	8-12	10-15	7-11
	Average	10	13	9
2	Number of Megaspores/ sorus			
	Range	5-7	4-9	4-9
	Average	7	7	6
3	Number of Microsporangia/ sorus			
	Range	5-14	5-10	4-7
	Average	10	8	6
4	Number of Microspores/ Microsporangium	64 (no aberrant spores)	64 (16-24 normal spores)	64 (12-24 normal spores)

numbers of normal microspores, and aberrant spores of various types are thus more frequent. Both increasing dryness and temperature are responsible for spore variation in *Marsilea* L. (Shattuck 1910).

Aspects of heterospory, specially microsporal aberrations, so frequent in some species of *Marsilea* L., have been studied in detail by Bhardwaja and Wadhwani (1984), and Bhardwaja (1986). Sen (1989), Soni (1989) and Wadhwani (1989) have discussed apogamy and parthenogenetic development of sporelings in *Marsilea* L. and have correlated microsporal aberrations with apogamous and parthenogenetic sporeling formation.

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December 19, 2001

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53. A COMPARATIVE ECO-ANATOMICAL STUDY ON THE RHIZOME OF THREE INDIAN MARSILEAS

(With one plate)

A study was conducted on the variations in the Rhizomes of the three Indian species of *Marsilea* L. namely, *Marsilea coromandeliana* Willd., *Marsilea kedarmalii* (Bhardwaja *et al.* 1994) and *Marsilea shashibalii* (Bhardwaja *et al.* 2000). *Marsilea coromandeliana* Willd. and *M. kedarmalii* Bhardwaja *et al.* were collected from the southern states of Kerala and Tamil Nadu respectively. *M. shashibalii* Bhardwaja *et al.* was collected from Kota district, Rajasthan and studied to investigate the eco-anatomical variations present among the three species.

Genus *Marsilea* L., well known for its amphibious nature, flourishes with equal ease in aquatic as well as in strongly xeric habitats (Bhardwaja 1966). It is, therefore, possible to categorise its various species as xeromorphic, amphibious or hydromorphic forms. Anatomical studies of ferns and fern allies, with special reference to stelar system, have been extensively investigated during the last century. Pande (1923) reported the presence of dictyostele in the tubers of *Marsilea erosa* L. and oil as the storage product in its cortex. But a critical study of this genus with special reference to land and water forms has not been made so far.

Land and water forms of all the three species were cultivated in the botanical garden of the Government College, Ajmer, Rajasthan. Different cultural practices were followed for land and water forms (D'Souza *et al.* 1993). Land forms were raised in pots, and given a measured quantity of water on alternate days. Water forms were raised in pots placed under water in a tank.

Hand and microtome sections of the rhizome were taken using the Tertiary Butyl Alcohol (TBA) Method for dehydration followed by paraffin embedding. 10-15 mm thick sections were stained using Safranine–Fast Green and mounted in DPX.

The study shows that there are a number of significant anatomical variations in the land and water forms of the three species of *Marsilea*.

The epidermis is thin-walled in the water forms, whereas it is thick in the land forms. Among the three species, *M. shashibalii* Bhardwaja *et al.* has the thickest epidermal wall. The inner cortex is parenchymatous in the water forms, whereas it is sclerenchymatous in the land forms. All the water forms have abundant aerenchyma in the outer cortex, compared to the land forms. In the land form of *M. shashibalii* Bhardwaja *et al.*, aerenchyma is nearly absent. The inner cortical cells of the land forms contained starch grains. These were abundant in the land form of *M. coromandeliana* Willd., but absent in the water forms of all the three species.

The stelar perimeter of the rhizome in the land forms is comparatively larger than that of water forms. The lignification of xylem elements reveals differences in land and water forms. The land forms having thicker lignin deposition, while water forms have poor lignification of tracheides. The pith in land forms is highly sclerotic, particularly in *M. coromandeliana* Willd. The pith of all the water forms was characterised by the presence of tannin cells. Tannin is known to provide protection against microbial growth in water plants (Farkas and Kirlay 1962).

Thus, *Marsilea* L. shows adaptation to a wide range of habitats from aquatic to subterrestrial, terrestrial and xerophytic. Gupta (1962) stated that water is an important ecological factor in bringing about variations in size and shape of vegetative organs, and has probably led to the differentiation in terrestrial

and hydrophytic forms in *Marsilea* L. Allsopp (1963) observed that land and water forms show striking phytochemical differences. Wadhwani (1983) reported that land and water forms of *M. diffusa* Lepr. respond differently to the same cultural regime. Water forms of *Marsilea* L. are reported as more labile to hypothermia than land forms (Joseph 1998).

In this study, all the three species of *Marsilea* L. exhibited significant morphological variations between land and water forms. Evidently, the amount of water available had a great impact on the morphological and anatomical differences in land and water forms.

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■ ■ ■

Joseph, T.S. and C.B. Gena: *Marsilea* spp. PLATE 1

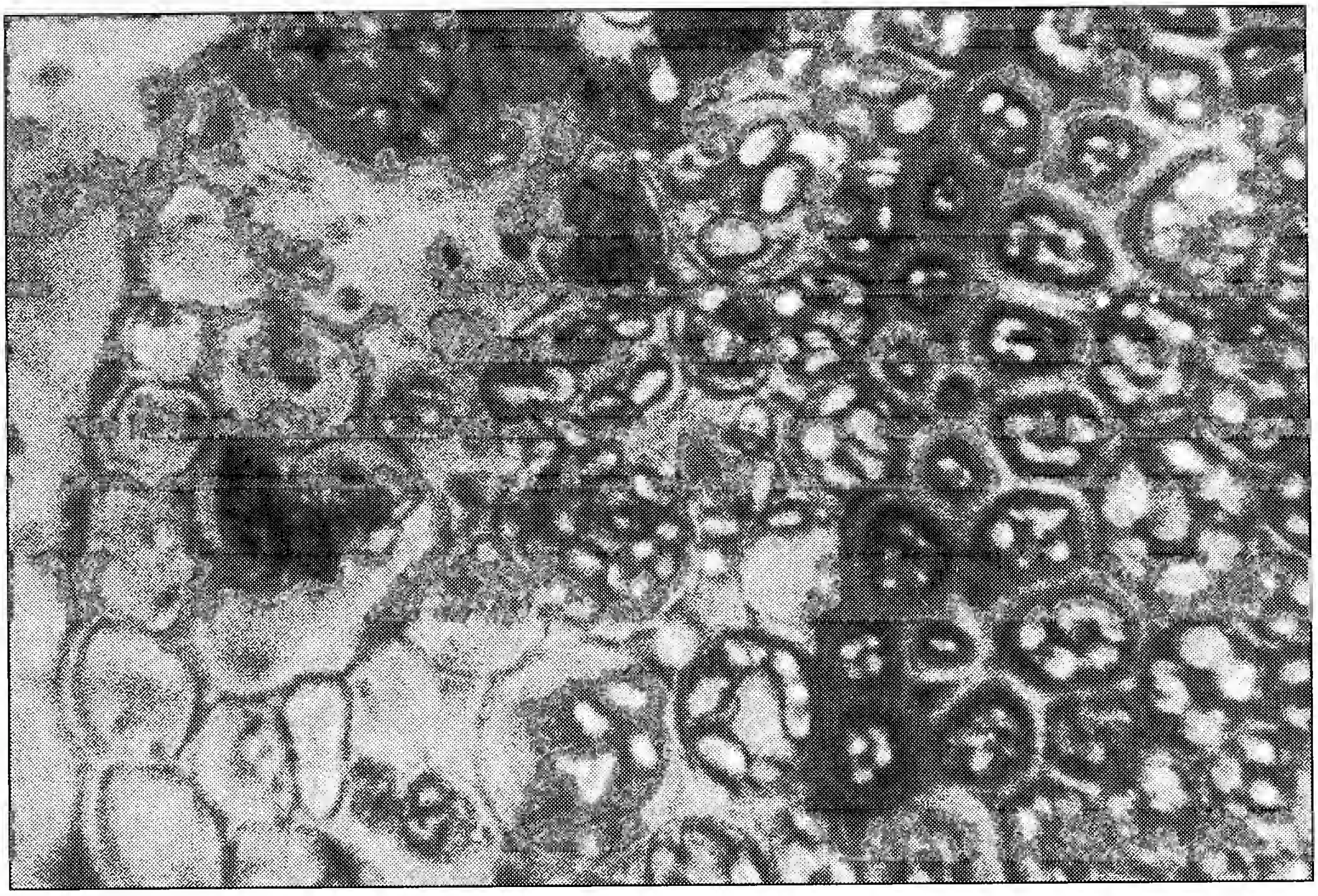

Fig. 1: Magnified view of rhizome: T. S. of *M. coromandeliana* Willd. showing cell wall thickness, starch grains and aerenchyma (Land form)

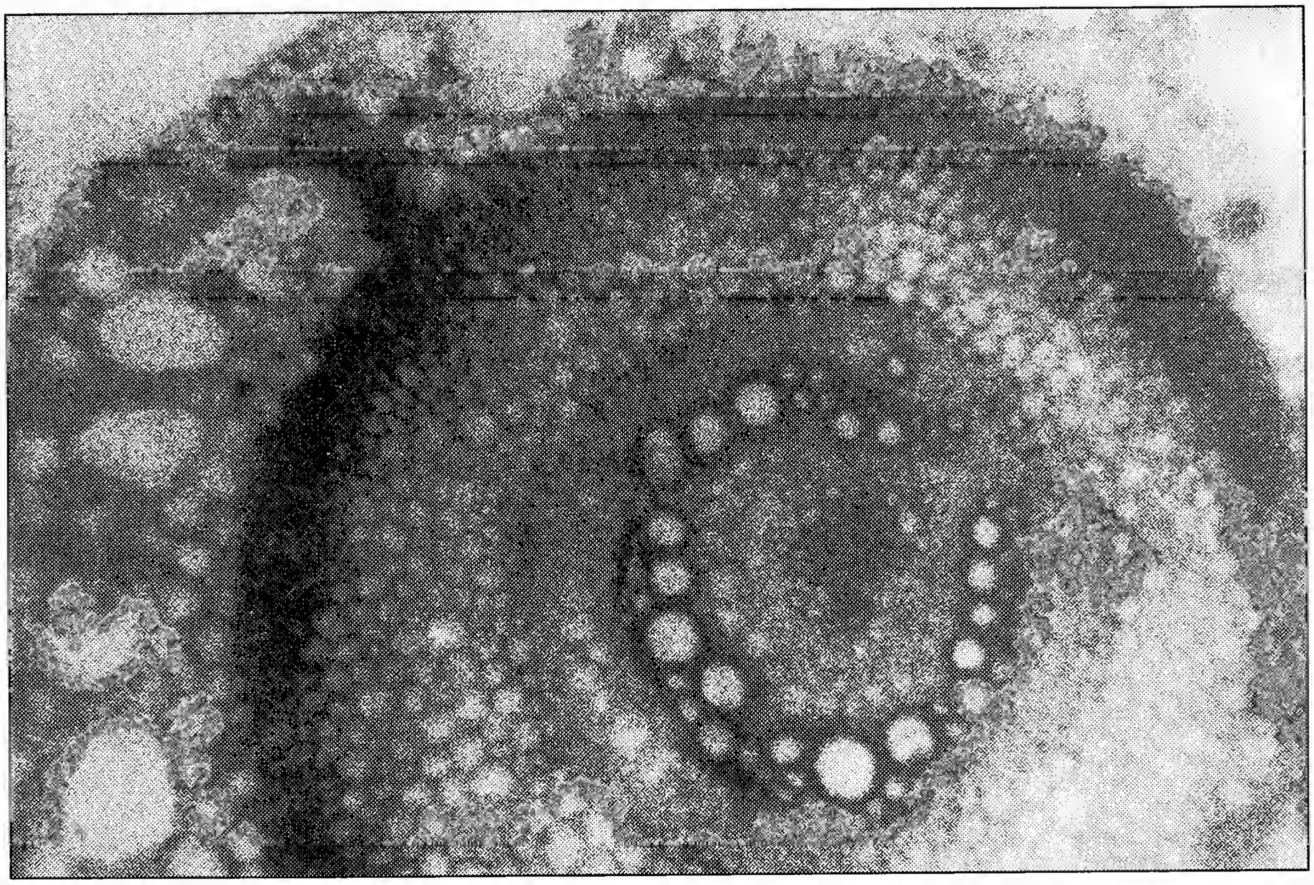

Fig. 2: Magnified view of rhizome: T. S. of *M. kedarmalii* Bhardwaja *et al.* showing cell wall thickness and aerenchyma (Land form)

ERRATA

In Vol. 99(2), August 2002

Page 300 for Miscellaneous Note No. 13. read the title as:

SIGHTING OF A RUFOUS-NECKED STINT *CALIDRIS RUFICOLLIS* (PALLAS) ON INDIA'S WEST COAST

Page 348 for Miscellaneous Note No. 34, second column, 4th line

For: Wynter-Blyth (1957) does not mention *Alpinia calcarata* Rosc., occurrence and successful rearing of Grass Demon *Udaspes folus* Cram., and Restricted Demon *Notocrypta curvifascia* Felder & Felder on *Alpinia calcarata* confirms it as a new larval food plant for both the species.

Read: Wynter-Blyth (1957) does not mention *Alpinia calcarata* Rosc., as the food plant of both Grass Demon *Udaspes folus* Cram., and Restricted Demon *Notocrypta curvifascia* Felder & Felder. The occurrence and successful rearing of Grass Demon *Udaspes folus* Cram., and Restricted Demon *Notocrypta curvifascia* Felder & Felder on *Alpinia calcarata* confirms it as a new larval food plant for both the species.

Page 379 for Miscellaneous Note No. 49, Table 1

For:

Sl. No.	Latin name	Local name	Family
1.	*Abrus precatorius* Linn.	Chaning (M)	Malvaceae
19.	*Crotalaria mucronata* Derv. Sen (H)	—	Papaveraceae
20.	*Dalbergia stipulacea* Roxb.	—	Papilionaceae

Read:

Sl. No.	Latin name	Local name	Family
1.	*Abrus precatorius* Linn.	Chaning (M)	Fabaceae
19.	*Crotalaria mucronata* Derv. Sen (H)	—	Fabaceae
20.	*Dalbergia stipulacea* Roxb.	—	Fabaceae

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